Engineering Thesis.

1883.

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Preface.

Much of the matter contained in the following pages is a compilation from articles, pertaining to the subject, which have appeared in various pamphlets and journals and from reports of committees. This is necessarily so from the nature of some of the subjects treated of.

Thus, the history of the waterfront & of the bulkhead wall and piers, had to be almost entirely compiled from reports & proceedings of former and existing departments and committees.

I trust that I have brought together in one article

the facts relating to the history of the waterfront, which are now to be altered through many articles & reports.

On the other hand, in those subjects where it was possible I have endeavored to add as much new matter to the existing literature as I could collect in my study of the subject. The improvements now in progress were visited nearly every day for about six weeks and during these visits note was taken of the methods of working, & constructing the river wall and piers.

A list of all the references I have been able to collect, and have used, is given at the end of the thesis.

Owing to the slow rate at which the work progresses and the fact that the most important part of the river wall is below water, very few drawings could be made from actual measurements. I am however enabled to profusely illustrate this thesis, through the kindness of Mr G.S. Greene engineer-in-chief of the Department

of Docks and Mr. T. J. Long, assistant engineer, who gave me carte blanche to all the tracings and drawings of the Department.

I took blue prints of the most important tracings, & tracings of the important drawings relating the subject of this thesis, and these are to be found at the end of the thesis.

The maps are from Reports of the Department of Docks and other sources.

Contents.

History of Water Front.

In considering the improvements along the Hudson River in New York City, and the construction of the new piers and bulkhead wall, it will be both interesting and instructive to look into the history of the water front.

By knowing the earliest wharf accommodations, the improvements & changes which have from time to time become necessary & the difficulties which have been encountered, we can better understand the origin of the present system of water front improvements, & can appreciate the great benefits

to be derived therefrom.

The history of New York City begins with the discovery of the Hudson River, & the island upon which New York now stands, by Henry Hudson in 1609. As early as 1610, the Dutch West India Company sent a ship to Hudson River to trade, and the first immigrants devoted themselves exclusively to traffic, and therefore probably had landing places. The first regular settlement on the island was a trading post, established at its southern extremity in 1615.

The earliest record, we have, connected with wharves and docks in the city is in 1654. It is stated that in this year Daniel Litchoe, a tavern keeper, was authorized to build a dock in the strand. By 1656 the settlement had increased to 2000 souls & a brisk trade in fur & tobacco was carried on with Europe. A map published in that year shows at least one wharf near the present site of the Battery.

This may perhaps be the dock built by Litchoe.

In 1661 an ordnance was passed, according to which the tenant masters had received permission from the Director General to exact a certain sum from shippers and owners for the erection of a pier for the accommodation of the inhabitants of the town.

In the year 1672 the province of New York owned 6 ships of 100 tons burthen, trading with Europe.

A new dock was built in 1676. This is the second dock we have any record of. It was paid for out of a tax levied on 30 merchants. Mention is made in the Dongan Charter (1686) of "the bridge into the dock and the wharves or docks and their appurtenances". On a map published in 1695 there appears an enclosed dock just east of Whitehall street with a bridge and pier running into it. This is without doubt the one referred to in the charter of 1686, and another at the foot of Whitehall street marked as the "new dock".

From these facts it appears that as far back as 1686 a city, and a dock system.

In 1728 the dock system as shown by the map of an actual survey made by James Lyne (see Map of New York City Plate I) consisted of alternate narrow slips & broad "keys" or moles.

The docks extended up the East River for about a mile above the Battery. On the Hudson River only four jetties or wharves appear. These were closer together than those on the East River & not so broad. Their site was on Stone, Little Queen, & Crown streets, now Thames, Cedar & Liberty. (see Plate I). Though the docks on the East River extended up a mile from the Battery they furnished a comparitively short wharf line for the extent of water frontage on account of the great distance between the slips.

From a map by J. Hills, 1782, it appears that the dock system had been entirely changed, a largely increased

active + localized commerce requiring a greatly extended wharf line within a limited extent of water front, necessitated the adoption of the present system of narrow wharves + slips, by which arrangement the longest wharf line is obtained with least given shoreline.

The following gives an idea of the extent of filling out which had been carried on into the two rivers; In 1687 Water street on the East River had not yet been built and its inner line coincided with the low water mark of that date, just east of Whitehall street. In 1739 high water mark on the Hudson River was 9 feet east of the easterly line of the present Greenwich street at its southerly end.

The ordinances of 1795 & 1796 and the Legislative Acts of 1798 and of 1813 amending the same established South + West streets as the exterior limits of the City along the rivers, giving a width of 70 feet to each of these streets

These acts gave permission to the authorities to change

and widen the streets as the growth of the city demanded.

On account of the wretched condition of the water front a meeting was held by the citizens of New York City, May 5th 1836. A Report relative to the erection of a Great Pier, made in that year says "in 1832 the growing deficiencies of wharf & slip room had become so generally manifest that serious wishes were entertained to extend & improve our commercial accomodations. No thought for the aid of shipping interests of the North River was therein contained as is shown by the Resolution adopted by the Mayor and Common Council March 1832".

During the year 1935 a Resolution was offered in the Board of Aldermen, proposing for the first time that the safety & utility of the harbor on the west side of the city should be secured by the erection of a stone pier or breakwater or mole parallel or nearly so to the shore and at a sufficient distance from the present

piers and slips to form a large and commodious basin.

This was referred to the committee on Wharves who reported that "they have been duly impressed with the great importance of this subject, not only in regard to the magnitude of the work proposed but also with reference to the interests of New York which are intimately connected with the providing of a sufficient number of wharves & slips to accomodate the increasing commerce of the city. At the meeting of the citizens above referred to they were in favor of building the mole or pier in the river.

Reference is again made to this mode of improving the water front in the report of the expert engineers appointed by the Harbor Commissioners in 1856 and again in 1863, in the Report of the Committee on Wharves and Piers.

It thus seems that this was a favorite idea of the people for improving the water front, and it seems curious

that the work was never carried out after having been recommended so often. The arguments generally advanced in favor of such a system, were that wet docks had been such a success in Liverpool & London. The idea, however, of wet docks for New York similar to those in Liverpool is false as will be shown ~~under~~ in the consideration of "Piers".

The two acts passed in 1795 & 1796 were still in force in 1853. By them authority was given to the city authorities to build wharves bulkheads etc. & to alter them as they deemed best.

The encroachments by filling along the shores had become so extensive that a Commission was appointed in 1855 to make a thorough investigation of the subject - to fix a system of exterior lines beyond which no structures should be built. The commissioners had extensive surveys made by members of the Coast Survey

& their reports, made in 1856 & 1857 contain much valuable information about the harbor. (Acting on the advice of a committee consisting of Superintendent Bache of the Coast Survey, General Totten and Commander Davis, the commissioners adopted a system of lines for the whole water front of the harbor under the jurisdiction of the State of New York. These lines are known as the Harbor Commissioners Lines of 1857 & were the legal lines until those of the Department of Docks were adopted in 1871.

One of the lines adopted was a Bulkhead line, it being the exterior limit of solid filling & the other the Pier head line, the exterior limit of piers. (These lines are plotted on maps in the Harbor Commissioners report for 1856 & 1857)

They recommended lines for the Hudson River as follows;

From Battery Place to Hammond street, the lines of bulkhead and pier head shall conform as nearly as possible

to those now (1856) existing. The bulkhead line is the present irregular line of solid filling, the pier head line is drawn from point to point in such a manner as to follow the general changes in direction of the bulkhead line and at a uniform distance from this point of 200 yards or 600 feet. This line cuts off the extremities of a few of the longest piers, but these may be allowed to stand till repairs are necessary when they may be made to come within the line. From Hammond street to 30th street we recommend that the bulkhead line be 13th Avenue, and from 30th to 75th that the bulkhead line be the 12th Avenue". These lines were subsequently somewhat modified, by request of the harbor commissioners.

That the water front was still in a deplorable condition in 1867 may be inferred from the following.

On the 5th day of April 1866 it was resolved that a select committee of six be appointed to sit during the

recess of the Legislature, and to take testimony and to enquire as to the condition of the piers wharves and slips in the cities of New York and Brooklyn and as to the ownership & occupancy thereof." The resolution contemplated an enquiry and examination both as to the condition and property of the piers, wharves bulkheads and slips of the harbor of New York From all sources the committee found that the condition of the piers wharves bulkheads and slips of the harbor of New York was most deplorable & a disgrace to such a commercial emporium as is the city of New York. "It may be safely said that of all the 17 miles of water front of New York not a single pier owned by it, unless those leased to and occupied exclusively ~~to~~ by ferries, steamships, railroads or some corporation who, by right or against law exercise absolute or entire control, is either commodious or safe". Hence general interests of commerce suffer & business demanding wharf accomodations is

drawn to New Jersey or elsewhere. The committee also presented a proposal for a canal basin for the accommodation of the canal boats," being simply an appropriation of the extensive water front of the Battery & being so much of the harbor as is fast filling up, but which at a comparatively small expense will furnish a basin with proper piers and slips for not less than 800 canal boats at all times".

Among other improvements they recommended that the streets bordering on the river be widened at least 100 feet, & that the harbor of New York should be placed under a special board bureau or commission to whom should be given the most ample powers and control.

In 1867 under the mayoralty of John T. Hoffman, the Commissioners of the Sinking Fund appointed a Board of Examiners to estimate the value of the wharf property belonging to the city, and to devise a plan for its improvement. They proposed certain repairs

& reported the following schedule of valuations and costs.

Present value of wharves piers & slips owned by the City	1579350
Cost to repair the same	111985
Value when repaired	1870740
Cost of extending as proposed	791560
Value when extended	2037700

This estimate covered the value of the structures themselves & did not include the value of the lots upon which they stood. The present (1870) value of these structures will at least reach 20000000 dollars.

The shore line & pier & bulkhead line in 1868 may be seen from the map plate II.

The increased demands of shipping and need of wharf facilities & facilities for the transhipment of freight at last caused the Legislature of 1870 to or-

ganize a Dock Department. The Board of Commissioners governing the Department of Docks was appointed April 9th 1870 and organized May 2nd of the same year.

The government of the Department was vested in 5 commissioners. They were to determine upon a plan of permanent improvement of the water front and the administration of all the wharf property belonging to the city and the regulation of the whole water front devolved upon them. This was the first successful step towards the adoption of a plan of permanent improvement of the water front.

The water front was divided into 5 districts on each River those on the Hudson river were;

1° Castle Garden to pier 22 inclusive
2° Pier 23 to a short pier a Laight street
3° Bulkhead north of Laight street to pier 54 inclusive
4° " " " pier 54 to 34th street inclusive.

5° Pier foot of west 34th street to Spuyten Duyvil Creek.

The first subject which engaged the attention of the board was the improvement of the water front of the city and establishment of permanent wharf accomodations for special commercial interests. They say in the 1st Report

"The plan of docks proposed is embraced in the general system of protecting the river front by a permanent river wall of masonry carried out from the present bulkhead line a sufficient distance to make a river street 250 feet wide on the North River and 200 ft. on the East River to 31st street. From this river wall piers will be placed at such intervals as will give the greatest accommodation to shipping."

"It is intended so as to go to as little expense as possible to extend these improvements to such a distance only as is necessary to give ample wharf facilities

for the present commerce of the city. They can be further extended as the increasing commerce requires accommodation".

The commerce in 1871 was accommodated by the following extent of wharf facilities viz; North River from the Battery to 61st street, a bulkhead with an aggregate length of 23163 feet and an average length of piers of 31229 feet with a pier area of 1606024 square feet. East River from the Battery to 51st street 24494 feet of bulkhead and an average length of piers of 14139 ft. with a pier area of 716644 sq. ft.

Thus the bulkhead and piers together gave a wharf line of 150,293 feet or 28½ miles with a pier area of 2322668 sq ft. The report goes on to say that in the proposed system the piers & river wall together will give a wharf line of about 195000 feet or about 37 miles, & the piers alone will have an

area of about 5105000 sq. ft., sufficient it is safe to say to accommodate a commerce vastly greater than that which now finds its way to New York.

It thus appears that for a very long time it will not be necessary to extend the new system further than 61st street North River & 51st street East River. — The proposed arrangement will give between Grand street and west 11th street, a wharf line of $21\frac{43}{100}$ miles (greater than the whole existing quay line of Liverpool including the constructions at Birkenhead which amounts in all to 20¾ miles.) against an existing line within the same limits of 20⅞ miles.

The new system of docks was adopted by the Board governing the department April 13th 1871 and was approved by the Commissioners of the Sinking Fund April 27th 1871.

A bulkhead line & pier line was proposed by the Department of Docks, which should supercede the Harbor Commissioners Line. These lines were adopted by the Legislature in 1871 and are now the legal lines. They are shown for the Hudson River on the maps of the Dock Department for 1882, Plates 3, 4, 5, 6 & 7. The line of limit of grant of lands under water is also shown.

A stone pier was also begun in this year as an experiment, to see wether it would pay to build stone piers. It was completed in 1875. It did not prove a great success & no more stone piers have been built. The matter of stone & wooden piers will be discussed under "Wharves".

During the latter part of 1871 & early part of 1872 12 new piers were constructed 30 piers rebuilt & repaired and 10 bulkheads rebuild & repaired.

The portion of the river wall which was commenced during the Summer was completed to nearly low water mark. In September 1872 a contract was made for building a wooden pier at 31st street North River, on the improved plan. During the year borings were taken from 59th street North River to to Pier 43 East River & average depth of soft mud found to be 22 to 23 ft, though in some places it is much greater. By April 30th 1873 11 new piers were built & 26 piers, bulkheads & dumping boards rebuilt or repaired. The bulkhead north of Pier new No 1 was completed for a distance of 84 feet.

Reconstruction of Christopher street section from foot of Christopher street to Hammond street was begun in November 1873. The work of tearing up the old piers & dredging out the bottom was sufficiently advanced by December to admit of beginning to drive piles on the new piers & bulkheads. The new piers

44 45 & 46 were ready for occupancy May 1st 1874 & the slip between piers 43 & 44 was in process of re-construction. During end of 1874 & early part of 1875 work was steadily prosecuted at Christopher street section resulting in the completion of New pier 43 & Pier 47. The bulkhead wall from which the piers spring was also completed for a distance of 1115 feet.

Work was commenced on the King street section November 16 1874 & by April 30th 1875 147 feet were completed. Work on pier 34 was commenced May 4 1874 and the bulkhead adjacent was completed for a distance of 110 ft. by April 30th 1875. A new pier was also built at the foot of Jane street.

By 1876 the method of constructing the Bulkhead Wall had gone through two changes. These changes & the reason for them will be dicussed in the consideration of the "Bulkhead Wall.

In their Report for the year ending April 30th 1882 the Commissioners say that "the improvement of the district of the water front on the North river, between West Eleventh & West Twenty-third streets, is a subject which should receive the immediate consideration of all officers and departments of the city government in any way responsible for the future welfare of the trade.

In the Report of 1880 the Department proposed a plan for improving this district. This plan contemplates the extension of West street at a width of 250 feet, from the foot of West Tenth street northwardly in a direct line until it shall intersect the 13th avenue, just north of the foot of 22nd street. (See Plate 8) The plan further proposes the erection of at least 20 piers, extending westerly from this new bulkhead line as established by this proposed

extension of West street."

The Department cannot move in the improvement, until a law is passed by the State Legislature authorizing a change in the improvement of the water front from the plan adopted in 1871. The Board did not proceed on the latter plan, because the Commissioners were unanimously of the opinion, that a better plan could be devised for that portion of the water front.

"The existing adopted plan does not provide for the construction of any piers, & the plan in contemplation by the present Board will provide for piers quite equal in capacity to those south of West Tenth & north of west 23rd Streets.

Our North river water front south of West Eleventh Street is overcrowded with shipping and transportation lines, so that in event this proposed improvement is

not carried into effect, all new enterprises of commerce, as well as the increased facilities required for those already established, must either seek the desired accommodations above 22nd street, or be forced to cross to the opposite shores in Brooklyn and New Jersey.

By this improvement ample facilities will be secured, upon its completion, to meet the present pressing demands of commerce and trade, & a water front obtained for the new Market recently established at Gansevoort street. The growth of our wharf accommodations can then proceed northwardly, pier by pier, as necessity may require."

During the year ending April 1882 the construction of the new bulkhead wall on the North river water front ~~has~~ progressed as rapidly as possible, but the difficulty of obtaining possession of any considerable length of water front without seriously interfering with com-

mercial interests, together with the course pursued by several claimants to water front rights in restraining the Department by injunctions from improving the premises in conformity with the plans of the Commissioners of the Sinking Fund, ~~has~~ prevented the erection of the wall at the several points of the river front to the extent contemplated by the Department. Piers have been erected in proper place wherever the wall has been completed, the work being done by contract in each case.

The existing and proposed piers & bulkheads up to April 30th 1882 are shown on plates 3, 4, 5, 6, 7. as also Corporation & private property.

Work is now (November 1883) being carried on, on the bulkhead wall, between 30th & 31st streets North River & two piers, one at the foot of 29th & the other at the foot of 30th street are being constructed. A portion of the wall has just been completed at the foot of Saight street.

It was once suggested, that not only could West street be made commodious by widening it, but a railroad might be constructed along the bulkhead for passenger and quick transit combined with a system of warehouses and connecting not only with the docks & piers, but with the entire system of railroads converging to this port.

At a meeting of the Society of Civil Engineers, after the reading of a paper on the New York Wharves & docks, some interesting points, as to right place for the wharves of New York were brought out in a discussion.

Mr. Abel Welch said that the original location of the commercial metropolis of America was either Amboy or Communipaw. The right place for the wharves of N.Y. is on the west of N.J. side of the Hudson river where the railroads end. It cost $2 per ton to take goods from the railroads at Jersey City across the river to the warehouses, pay storage and ship them, nearly all of which is unnecessary expense

At Communipaw or Harsimus Cove or Hoboken there should be warehouses for goods & a method of inspection, such that the consignee or owner could make sales as in London, without the buyer ever seeing the wares. This is the true system, but it may be established in N.Y.C. but this island is not large enough for the purpose. The lower part of the city is the counting house of the continent, & there is not room for wharfage storage & the like. Mr Collingwood agreed with Mr. Welch, as regards the expense of transfer across the river & transhipment.

Mr. Steele, on the other hand, thought that some provision was needed for the trade from the Great Lakes, which come to New York by the Erie canal & along the east side of the Hudson river.

Though this is not so true now; as there is a railroad on the west side, it is still certain that New York must be provided with ample docks to receive goods & passengers that must come directly into & be shipped directly from the city.

Harbor and Port.

It is surprising to see what little thought and care was formerly, and in the early history of New York, was bestowed on the harbor. It does not seem to have occured to the people that certain precautions, and restrictions were necessary to preserve the harbor with its unrivaled advantages.

The value of, & the benefits to be derived from, the waterfront improvement of New York City is nothing when compared to the importance of preserving the harbor from encroachments & preventing the channels from being shallowed.

New York City owes its greatness to its harbor. From the earliest times, in the history of the country, vessels were attracted to New York on account of the excellent shelter found in its harbor. Since therefore the commerce of the city is directly dependent on its harbor, and since the extensive dock & wharf system is intended primarily to advance commerce & provide facilities for the loading & unloading of ships that are attracted to the harbor, it becomes important to so arrange the wharves, docks & water front improvements that they will not only, not encroach upon & injure the harbor, but that they shall improve it and increase their own value. Without a good harbor the docks would be unnecessary.

It will therefore not be uninteresting to look for a moment at some of the dangers which have threatened the harbor, as also at the present condition extent advantages etc.

It is of great importance that the docks be substantially built for if they are not they soon decay & fall to pieces & their debris tend to obstruct the harbor & form nuclei for deposits on the river bottoms.

The proposals in 1832, 1836 & subsequently, of building the stone moles already referred to, in the rivers, and especially in the Hudson, show in a marked manner how little consideration was given to the subject of limiting the encroachments on the river channels, upon the preservation of which the whole value of the harbor is dependent, the depths at the entrances of the harbor being governed by the volume and rapidity of the tidal currents.

As before stated, the encroachments by filling along the shores had become so extensive, that a Commission was appointed in 1855 to make a thorough investigation of the subject and to fix a system of exterior

lines beyond which no structures should be built. The commissioners had extensive surveys made by experts, members of the Coast Survey, their reports of 1856 & 1857 contain much valuable matter relative to the harbor.

Professor Bache in his report refers to the charges which have been made in the East and Hudson Rivers and lower bays between the years 1835 & 1853.

1° The Hudson river has deepened from 40th street southerly nearly 6 ft and the channel instead of being as formerly in the centre of the river is now on the New York side.

2° A considerable deposit has been made on the New Jersey side south of Jersey City."

The report continues that "it has been apprehended by the engineers that the upper waters of the Hudson river have been injuriously effected by the projections into that river at the city of New York. That the navigation

of the river may be injured ~~by~~ through its whole length by encroachments at its mouth cannot be doubted.

From the above we see the importance of considering and avoiding everything which will tend to obstruct the free flow of the rivers, in designing a system of docks for the city.

The relations which the harbor of New York sustains to the commerce of the United States, is such that questions touching injury to it are of national importance. The encroachments in the harbor, though they are local may produce general injurious effects.

The fear of encroaching on the harbor should not however prevent an extensive & liberal system of docks from being carried out, for the docks are a necessary part of the harbor, but it should only make the projectors careful in what they do, & do it in a scientific manner, and with a full knowledge of the limits allowable.

A committee ~~to~~ which met in 1863 for the consideration of the piers, reported that the immense masses of stone used to form blocks at the ends of the piers were frequently scattered over the bed of the river by the collapsing of the wooden enclosures. They thus impeded the current to such an extent that great deposits ensued & the slips were filled up in many basins, so that small vessels could hardly float where formerly it had been very deep. Such a state of affairs would, of course, ultimately destroy the commercial advantages.

A good system of docks is the more necessary for the Hudson river, as it is more exposed to the winds which generally blow from New Jersey. The ice in Winter is driven against the New York shore & frequent squalls occur, all of which make it necessary to protect the ships unlading at that shore, by a proper system of docks. This was one of the reasons a stone mole was

proposed.

The care of the harbor, to a certain extent, & the whole control of encroachments on the rivers, is now vested in the Dock Commissioners and it is to be hoped that the harbor will be preserved with all its advantages— further encroachments prevented.

The harbor of New York City is at present one of the finest in the world. It requires but a hasty examination to prove its natural advantages.

The bar is at Sandy Hook 18 miles from the city and has two ship channels, from 21 to 32 feet at low and 27 to 39 ft. at high tide, admitting vessels of the heaviest draught. The lower bay is a safe anchorage of triangular form, from 9 to 12 miles on each side. The N.E. angle opening into the upper or New York bay, through the Narrows, a deep channel between Long and Staaten Islands, about 1½ miles long by 1 mile wide. The upper

bay is an irregular oval, about 8 by 5 miles, opening northward into the Hudson river, eastward through the East river into Long Island sound and westward into Newark bay. The rivers immediately around the city are deep so that the heaviest ships can navigate them, while the bottom affords good anchorage. The tidal currents if not interfered with by obstructions, will usually keep the channels free from ice. The average fall & rise of the tide is 4.6 feet. Vessels can also pass to and from Long Island sound through the East river.

The lower bay contains 88 square miles available for anchorage; the upper bay 16 sq. mis; & the Hudson and East rivers 13½ square miles.

The Hudson river above the city is navigable, by vessels of large size, for nearly 160 miles, it is an important member of the system of internal navigation afforded by the canals & the chain of Great Lakes, by means

of which New York is made the most convenient point of export for products of the West.

The shoreline of the city consists of 13 miles on the Hudson 9¼ miles on the East river and two and a half miles on the Harlem river, which with the twelve miles secured by the late annexation makes a total of 36¾ miles of water front under the control of the city. Besides there are long reaches of water front of Long Island, Staten Island & of New Jersey, the interests of whose owners are most intimately connected with those of the city. In general the water is deep close to the shore line and on leveling off the ground the dock approaches are easy.

As to the boundary between the States of New York & New Jersey, it was agreed by the compact made in 1834 that "the boundary line between the two states of New York & New Jersey from a point in the middle of the Hudson River opposite the point in the west shore thereof

in the 41° north latitude, to the main sea shall be the middle of said river, of the bay of New York, of the waters between Staten Island & New Jersey, & of Raritan Bay to the main sea."

To give an idea of the importance of the port it will not be out of place to give a few figures relating to the imports, exports and tonnage of the port.

In 1791 the exports from New York to foreign ports amounted to $2505465

In 1832 the value of merchandise loaded and unloaded in this port was estimated at from $100000000 to $120000000 and in that year the number of vessels in the port in the busy season of the year varied from 500 to 750 exclusive of 50 steam packets.

The number of arrivals of foreign ports amounted to 1808 and the coasting arrivals were then between 4000 to 5000.

The total value of imports, for the year ending Sept. 30 1832, into New York was $53214402 of $101029266 into the United States. The exports amounted to $26000945. In 1834 the total registered & enrolled licensed tonnage for New York was 359222 tons.

The foreign imports & exports at the port were for the years 1860 & 1872 respectively $223692941 & $418515629 and $17514639 & $15161123. The domestic exports were for the same years, $120630955 & $270413674 respectively

Total annual tonnage of the Port in 1872 was;

	Engaged in Foreign trade	Engaged in Coastwise trade
Entered	3969339	1754810
Cleared	3748516	2331293.

Government & Management.

One of the causes of the neglect of the water front and the dangers to which the harbor was exposed, was the defective government. No special committee or board was appointed to exclusively take charge of this large and important business, and therefore it is not surprising to find matters as they were.

Now and then the attention of the people was called to the state of the piers & bulkheads, & meetings were held and resolutions adopted for the improvement of the water front, but these seem never to have been carried out for at each new meeting the disgrace

ful condition of the piers was deplored

In 1832 a Resolution was adopted by the Mayor and Common Council for the improvement of the slips & piers

In 1836 a committe met for the purpose of considering water front improvements & recommended the erection of the a great pier in the North river, & a meeting was held by the citizens May 5th 1836 for considering the advisibility of erecting it.

In 1855 a commission was appointed by the legislature to investigate the matter of shore line and of harbor encroachments.

A committee on wharves and slips, consisting of three members, met & reported on the advisability of substituting wood stone for wood in the erection of the piers.

In 1866 the state of the wharf accommodations was brought before the Senate. A committee of six was appointed to sit during the recess of the Legislature and to take testimony and enquire as to the condition of the piers

wharves and bulkheads in the city of New York and Brooklyn & as to the ownership and occupancy thereof.

It must be remembered that the condition of the harbor, influences, not only the city, but the state and even the whole United States since New York city is the principal port.

Among other things, the above committee recommended that the harbor of New York be placed under a special board, bureau or commission to whom should be given the most ample powers and control and whose terms of office should be beyond political caprice.

We learn the nature of the government at & before that time from the communication of Mayor Hoffman to the senate in 1867.

The supervision regulation and care of the wharves, piers and slips was reposed in the Board of Commissioners of Pilots, created by an act of the Legislature passed in

1853 & subsequently amended. The street commissioner was charged with the duty of making repairs to the extent of appropriations made by the Legislature.

All plans for the construction of the wharves were subject to the approval of the Commissioners of Pilots. They refused to sanction the building of sheds of any description although these would have been of great value to the lessees. They did not deny that the sheds would be of great benefit but they were undecided as to wether they had authority to allow their erection & so they refused to allow them to be built. Some sheds were nevertheless built & not interfered with by the Commissioners.

A move was made in the right direction when in 1870 the Legislature organized the Dock Department.

The Board of Commissioners governing the Department of Docks was entrusted with the selection of a system of docks & their construction, besides which it was given su-

preme authority over all structures and lands under water belonging to the city and power to order the repair and rebuilding of docks belonging to others than the corporation, according to plans and under the supervision of the engineers of the department.

The Board was appointed April 9th 1870 and organized May 2nd. It consisted of 5 commissioners appointed for a term of 5 years. Subsequently, and ~~now~~ at the present time, the board consisted of only 3 commissioners.

The commissioners are appointed by the Mayor + confirmed by the Board of Aldermen.

All money received from rentals is taken charge of by the Commissioners of the Sinking Fund and they make allowances to the Dock Department for the improvements of the water front.

The water front was originally divided by the Department into 10 sections or districts, and a superintendent appoint-

ed over each district.

Besides the superintendents, there is an engineer-in-chief and assistant engineers. All work & plans must be passed upon by the engineer-in-chief, and is then considered and passed by the commissioners at their meetings.

In pursuance with a law passed in 1871, the Board of Commissioners submit an annual report to the Mayor. The law provides that the Annual Report shall contain. First.- The name, occupation & compensation of all persons appointed & employed by the Board. Second:- A statement of the action of the Board for the past year. Third.- A list of the orders & rules made by the Board, & a description of the contracts made; the purposes & amounts of payments made, the leases made for what terms, at what rent, to whom & for what property.

The duties devolved upon the Department by law comprise, among others, the following, many of which are purely legislative, and were exercised by the State Legislature

prior to the creation of the Board:—

The management and supervision of all the piers + waterfront of the city. The duty of seeing that the whole water front property, both public + private, is kept properly dredged + in suitable condition + repair for general use. The making of rules + regulations as to the use of all the waterfront, + the setting aside of parts of it for such purposes as may be best calculated to promote the interests of the city. The duty of passing on all erections, structures + superstructures, + upon every proposed modification or increase of terminal facility on the water front.

The duty of carrying out the reconstruction, on the new plan, of the whole waterfront property. And, generally the obligation to watch over + promote the commercial growth of the city, by introducing from time to time, every practicable improvement into its wharf + dock system.

The Boar is now making every effort to regain possession of all property on the water front, belonging by right to the city.

There is a great deal of property along the waterfront, below high water mark, which is claimed by private individuals, but to which the city has an undoubted right & title.

Though formerly, before the organization of the Department, the expenditures for building & repairing the docks & wharves were greatly in excess of the receipts from rentals, this is no longer the case, for the receipts greatly exceed the expenditures.

The salaries of some of the persons connected with the Department are as follows:-

President of the Board $6,500 per annum, other Comissioners $3,000 each. Engineer-in-chief $6,000 p. annum. Assistant engineer $3,000 p. annum. Engineers man $1,200. Superintendents of Sections $2,500.

Bulkhead Wall.

The general system proposed in 1870 for the improvement of the water front, by the Engineer in chief, and has been carried out to the present time was,

First - To construct a permanent river wall of Beton and masonry as far outside of the existing bulkhead as to give a river street 250 wide along the North river, 200 feet wide on the East river from the battery to 31st street and 175 feet wide north of that point.

Second - To build piers projecting from the river wall of ample dimensions, adequate constructions

and so far as possible affording an unobstructed passage for the water.

Third: To cover these piers with substantial sheds suitable to the requirements of each case.

We thus see that the water front improvements consist of two classes of constructions, a river wall and piers, and the methods of constructing each of these ~~are~~ is to a certain extent independent of the other. That is to say the bulkhead may be constructed either of wood, stone or iron as also the piers, but the use of one of these materials in the one structure does not imply its use in the other

In other respects the two structures are closely connected, they being the parts of a whole systems of dockage.

As the bulkhead wall must be constructed before the pier, as the pier has its origin at the wall, we will first consider the bulkhead wall, in its former & present construction, its history, use and the modifications and im-

provements made up to the present time.

The changes made from time to time in the bulkhead line along the water front have already been fully considered, it remains however to consider the former methods of constructions their disadvantages & their inadequacy to the requirements.

Before the organization of the Department of Docks the bulkheads were all of timber cribwork, filled in with broken stone. The work of construction was done by contract and in the most slovenly manner, the timber of which the bulkheads built were, was subject to conditions bringing about rapid decay, causing them to sink, slide out, and overturn.

We find constant reference made to the poor construction of the bulkheads in the reports of the committees that met from time to time to consider the state of the water front, & to which reference has already been made.

Mr. Renwick in the Report of the meeting in 1836 states that the accumulation from of stone from collapsed piers & bulkheads was so large that it would pay to remove it.

From Reports of the Senate Committee in 1867 we find that at that time the bulkheads had not yet been improved, nor had the streets bordering on the bulkheads been widened for they say "they find the streets obstructed, narrow, and entirely inadequate to the proper delivery & discharge of merchandise."

The method or plan on which these cribwork bulkheads were constructed may be seen from Plates 9, 10, 11 & 12. which are working drawings of the Department of Docks, for repairing temporarily the old bulkheads which have become broken. Of course these old bulkheads will be replaced by the new system as soon as work ~~is com~~ can be commenced on such that section of the water front that it is situated in.

Plate 9 shows the plan and elevation of the repaired bulkhead between 78th & 79th street North river. The rectangle at A shows the position of a drain coming through the wall. This drain is shown in detail on Plate 12. The drawing explains itself. The location of the bulkhead in this particular case is shown on Plate 10. An end elevation & transverse section are shown on the same plate.

The details of the upper portion are shown on Plate 11 the left hand figure being a transverse section & the other a front elevation. The sheathing of boards A A are to finish off the ~~top~~ portion above low water line & prevent injury to the cribwork by water rats.

As before stated these plates are not an exact representation of the bulkheads as they were formerly built but merely give the principle of their construction. If they had been constructed in accordance with the drawings mentioned they would not have been such a source of trouble,

& would have served their purpose.

No doubt the logs used were small and weak and put together in a rough manner & the stones for filling small & carelessly put in so that they soon worked their way out through the spaces between the logs.

In 1870 the Dock Department was organized, & the Engineer in chief at once set to work to devise a system of waterfront improvement. This system has already been mentioned. As part of this system it became necessary to devise a bulkhead wall which would answer the requirements of the case.

The Board advertised on the 16th of July 1870 that they would receive plans &c. for the improvement of the water front. Many were sent in and suggestions obtained in this way, but none of the plans were adopted.

Generals Humphrey and Gilmore were called upon

to consult with Genl. Mc Clellan, the Engineer in chief of the Department. The former with regard to injury to the harbor & the latter in regard to the crossection of the proposed wall.

Plans were finally determined upon april 13th. 1871 & submitted to the Commissioners of the Sinking Fund who adopted them.

The river wall was to be extended so far beyond the then existing bulkhead as to give a river street on the Hudson river 250 wide.

In the construction of the river wall up to the present time, three distinct plans have been followed, all consisting however essentially of a foundation of piling, ballasted with broken stone, from which the concrete structure is carried up nearly to mean low water, the wall above consisting of a granite facing with a concrete backing.

The first system was very good, but a little expensive. In trying to cheapen the construction, Genl McClellan's successor adopted a new plan, which however, though cheaper, proved to be of faulty construction. This method was therefore abandoned & the present system substituted by Mr G. S. Greene; Genl Grahames successor.

I now propose to describe these three systems, by aid of the blue prints, & discuss the advantages of each & the reasons for changing from one to the other.

The first system is known as the "beton block" system. A cross section of the wall built on this system is shown on Plate 13.

The river wall has been built by this system, for a distance of about 100 feet north of pier no. 1. On the Christopher Street section, included between Christopher & Hammond streets, 1115 feet were completed by April 30th

1874.

The wall is composed of beton blocks weighing from 25 to 50 tons each, they are each 6 feet high and laid in two courses. The cross section thus shows four blocks.

The blocks extend to within about 2 feet of low water mark. Above this a facing of granite is laid, and this is backed with concrete, dumped in and rammed.

The wall is founded as the bottom requires, on rip rap or piles, depending on the amt. of mud and depth to bed rock and the nature of the river bottom. The method on piles was most generally used owing to the depth of mud.

The Tracings Plates 15 16 + 17 show the results of borings taken in 1871 and subsequent years. These give an idea of the strata of the river bottom and show the great depth of mud at some places. Sometimes the bed rock cannot be reached by the piles & they are supported merely by the friction of the mud against

their sides.

In laying the blocks on rip-rap the foundation is first leveled off with broken stone and over this one foot of concrete is laid. A sweep resting on two guide boards laid on the extreme edges of the foundation being used for the latter operation. The blocks are then laid by means of a derrick. A light frame of wood supporting two vertical guides boards being ~~used for the latter operation~~ placed on the top surface, as the block sinks the alignment is made altogether by means of these rods which project above the water. The blocks are then loaded with about twice the weight they are to bear, for some ~~some~~ months before the superstructure is added. Sometimes the blocks are forced down by the weight nearly 1 foot, sinking however very evenly.

In making the pile foundation, the river is first dredged to firm bottom. The piles are firmly driven and then sawed off by means of a circular saw to an even bed. Cobblestones

are then packed between between the piles and leveled off with concrete, as shown in plate 13. Rip-rap is piled in front of and back of the foundation.

A series of relieving piles are driven back of the wall to help support the filling, of sand and rubbish, which goes to form the river street.

As before stated, the blue concrete blocks are formed in the open air and allowed to harden before being deposited in place. Plate 14 shows the mode of making the blocks. From the Plate it will be seen that they are made in wooden boxes or moulds. The cheeks or sides of the moulds are jointed together and may be removed leaving the block free when hardened. The concrete is wheeled to the top of the mould in a barrow dumped into the mould, & then spread evenly with a shovel & rammed with a beetle. In this way the block is built up. Two fillers AA are placed on the sides of the mould so as to form grooves A'A' in

the block. These grooves are to allow the chain used in lowering the blocks, to pass up the sides without touching the block already set, and to prevent it from chipping off the edges.

The blocks were lowered into position by the 100 ton derrick of the Department of Docks.

The blocks were at first composed of 1 pt. Portland cement 2 pts. sand & 5 pts. Bergen trap, broken to pass through a 2 inch ring. These proportions were subsequently changed to 1 pt cement 2½ pts sand and 6 of broken stone.

When the concrete is laid loose under water the proportions were changed respectively to 1, 2 + 3 or 4 parts.

The resulting weight of the block is from 150-152 lbs per cubic foot. The crushing strength is after 8 months from 944-1666 lbs. per square inch and after 6 days from 527-1055 lbs. per square inch

The cost of a cu yd of the blocks was $12.50. With cement

at $5 per barrel the materials alone cost $ 8.50 per cu. yd.

Considering all expenses it cost the city $16 per cu yd. laid. The maximum performance in laying was was 14 blocks weighing from 25-50 tons laid in one day of 10 hours.

In the month of July 1873 General Charles K Graham was appointed Engineer in chief of the Department of Docks in place of Genl. McClellan who had resigned.

In month of October 1874, with a view to more economy in the construction of the sea wall, the engineer-in-chief recommended to the Board as a substitute for beton blocks, that concrete en masse should be formed on a foundation of piles in a wet caisson, the concrete being lowered to its place within the caisson by appropriate machinery and kept to harden in a solid mass.

In November following the Board by formal resolution adopted the recommendation of General Graham and ordered the work to proceed, which was done.

Plate 18 shows a section of the wall at Canal street section build on this plan, with the exception of the relieving platform at the back. The latter was afterwards recommended by a committee of engineers, in order to strengthen the wall. Part of the wall in King street section was also build on this system. Work was commenced on the King street section November 16th 1874 and by April 30th 1875 147 feet were completed. On the Canal street section 110 feet had had been completed up to the same date & 80 feet additional ~~were~~ was ready for the superstructure & facing. At Clarkson and Lawson streets the piles for this system had been driven, but no other work had been done.

In constructing the wall on the "beton en masse in situ" system, the site of the wall was first thoroughly dredged to a mean depth of 20 feet below mean low water. Piles were then driven eight in a cross section of 17 feet 6 inches and of an average distance of 2 feet 6 inches from centres

centre except the front rows which are centered two feet longitudinally. The outer and inner rows were driven as close as could be done without interference; they were punched down to about a mean distance of 13 ft. below mean low water by means of a heavy oaken follower, 26 feet in length & 12" in section armed at the bottom with an iron pintle and banded with iron to strengthen it against fracture. This punching obviated cutting off any other than the westerly row.

This uneven punching was thought to offer a good grasp to the concrete around the heads of the piles. Intermediate broken stone of an average 4" cube was then filled in between the piles and allowed to take a bearing. The false work for receiving the concrete was then erected. Squared yellow pine piles 12"x12" in section were driven in front of the westerly row of punched piles and at a batter of 1¾ to the foot & on the back at a batter of ½" to the foot, Centered longitudinally 8 feet to the inside of these square piles previous

to their being driven; battens of 4"x2½" spruce were nailed on firmly and on these further pieces 12"x2" were fastened, forming grooves for receiving wooden shutters which were slid into place after the pile alignment was perfected.

These piles were then capped crosswise by 12" square lintels, braced laterally by walling pieces 12"x6" and on these cross caps, stringers were laid on which were placed rails of flat iron to receive the wheels of a movable platform car bearing on it a 10. H.P. engine, for the lowering of the concrete into the basin caisson. The concrete was mixed on a platform at the rear of the wall, wheeled in a car & dumped into the buckets or tubs and lowered into the caisson. A string was then pulled, opening the bottom of the buckets, and the concrete was thus deposited. The top of the whole mass was finally levelled off by a diver, to receive the granite facing & superstructure. The proportions used in making the concrete were, 1 pt. Portland cement, 2 pts. sharp sand.

+ 5 pts small broken stones.

The object of the caisson was to give shape to the block to prevent its being washed away by the water while being deposited & to hold it in shape while hardening. The caissons were removed when by probing the stone proved to have set.

A new board of Commissioners was organized on May 2nd 1875 and on the following 2nd of June General Graham resigned his office. As soon as possible his successor George S. Greene was appointed to fill the vacancy.

The attention of the commissioners being called to possible defects in "beton en masse" system of construction the subject was referred for investigation to the Executive Committee who directed the engineer-in-chief to make a careful examination of the work & report the results.

Difficulties, of course, attended the examination in turbid water, but the results obtained were enough to excite grave

apprehensions in the minds of the commissioners as to the safety of that part of the wall covered by the report of the engineer, and a request was made to the Mayor to appoint 3 experts to examine into the case.

12 Oct. 1875

The mayor appointed Generals John Newton + Quincy A Gilmore U.S.A. & Mr Wm E Worthen of New York to conduct the investigation.

They examined all the wall that had been built, by the aid of divers and also built an experimental wall, in exactly the manner in which the regular river wall had been built, on a caisson and subjected it to conditions as nearly approaching those existing in the river wall as possible by sinking it in the river. The caisson was afterwards raised and examined. The concrete was found to have fallen away between the piles, so as to create serious doubts as to the stability of the river wall already built by this system. The Board of Engineers

in their report say that "the mode of construction with the details appliances and materials used is uncertain in its results."

In regard to completing the structures commenced on this plan, the Board of Engineers recommended that where as in Canal street & King street a wall had been built it should be strengthened by building a platform in the rear to relieve the pressure from the filling yet to be put in. This modification is shown on Plate 18.

For such places as Clarkson and Houston streets where the piles had been driven but no masonry had been laid, they recommended that a wall be built of blocks of concrete made in air and laid as headers and stretchers in front and rear and the spaces filled with concrete in bags & concrete deposited by a tremmie. A relieving platform was also to be built in the rear of such walls and fastened to them.

Plate 19 shows a cross section of the wall as recommended for upper & lower Clarkson street and plate 20 shows in plan the arrangements of headers & stretchers.

This plan was further modified & Plate 21 is a cross section of the wall as built at the foot of Morton street, & recommended by the engineers

The work however proceeded all this time on no system that was to be permanently adhered to, but was only a method of completing work that had already been started.

I omitted to mention mention in speaking of the first system of improvements that the cost of construction between Grand & West 11th. street was computed to be as follows

4 33/100 miles of river wall at $25000 per mile = $473 per ft = $10 825000

Piers 9 175000

20 000000

I have not been able to obtain data as to the cost by

the "beton en masse" system

On April 5th 1876 Mr Greene submitted to the Board an elaborate plan for a new wall suitable for the section of the city between Morton and Warren streets, a section with great depth of mud. See plates 16 & 17 piers 29-50. The plan was adopted formally by the Board after consultation with the aforementioned experts.

It is the same system which is being used at present & which has proved very successful

By April 1877, 114 feet of the wall had been completed at the new King street section and 270 feet more were in process of construction. The cost of the first section was $263 per lineal foot but it was expected to reduce the cost to $200 per foot. This compares very favorably with the cost, $473 per lineal foot, of the first system. The amt. of wall completed up to 1882 by all the systems is shown by the full lines along the bulkhead line of 1871

on plates 3, 4, 5, 6 + 7.

Cross sections of the wall are shown on plates 22 and 23 and elevation on plate 23a + a section plan on plate 24.

The first thing done in constructing the wall is to remove the old cribwork structures. The site of the wall is then dredged to hard + compact sand and mud, for about 50 feet on each side of the center line of the wall. The depth of dredging below mean low water varies from 30 to 35 feet.

Cobblestones, up to 6", maximum size, are then thrown on the bottom from scows + the filling brought up to 22 feet below mean low water. The cobblestones occupy the width of the wall. At the same time as the cobblestones are being deposited rip rap is dumped in the front + rear of the cobblestones as shown on plate 22. The largest piece of rip rap allowed being 15" in its ~~largest~~

greatest dimension. The cobblestones and rip rap prevent the mud from filling in again and furnish a good stratum for ~~the~~ maintaining the piles in position.

Before proceeding with the description it may be well to remark here, that the bulkhead wall consists really of a mass of cobblestone & ~~con~~ rip rap. The core being ~~rip~~ ~~cobblestone~~ filling filled in with cobblestones the outside being rip rap. In order to give a permanent form to the top of the wall and afford a place against which ships could lie while discharging a facing ~~of~~ consisting of a concrete block and granite was constructed. The cobblestone is only carried up to mean low water, above this the wall consists of a granite facing, with concrete backing & still further back ~~of~~ Earth filling, ~~in~~ put in to form the river street.

After carrying the cobblestone & rip rap up to 22 feet

below mean low water, The piles are driven, The arrangement being as shown in plates 22 23a 23+ 24. The piles are of pine and average 85 feet in length + are 15" diameter at the butt end + 6" at the small end.

They are placed transversely, by means of sights placed on the part of the bulkhead already completed. Between every other tranverse row, bracing piles, as shown in ~~figure~~ Plate 23, are driven. These are driven with the same pile driver as the others only in this case the beetle slides in inclined ways. The piles are aligned + kept at the correct angle by sights, as before.

The hammer used weighs 3600 lbs + is raised 10 ft in giving each blow. The bottom is concave, the middle ordinate to a 21" chord being 1/8".

Over + between every 8 row of piles, binding frames, shown at A A + in plan, on plate 23, in position on plates 23a + 24 + in detail on plate 25, are slid.

They are put together on the surface of the water between the piles & then sunk by weighting with iron rails, and hammered into position with the hammer of the pile driver. A diver is then sent down & fastens the frame to the piles, after which the rails are hoisted up for future use. Wedges are then driven btween the outermost & innermost rows of piles & the frame so that they touch at every point. Cobblestones are then filled in to the bottom of the base blocks of the wall.

The duty of the binding frames is to hold the front rows of piles, in case there should be any tendency in them to tilt or bend outwards.

The three foremost piles are now cut, to receive the concrete block, at a depth of 15.293 feet below mean low water. They are all cut to a uniform height, by means of a horizontal circular saw, whose shaft is supported in the ways of a pile driver. The saw is kept at the proper height by

sighting on a mark on the shaft & keeping it in sight through an engineers level. The bracing piles are now cut off at right angles to their axes about 1 foot below mean low water, & capped with 12" square timber running longitudinally.

In order to secure an even cutting, a buck saw sliding in the frame shown in the top figure of plate 25 is used in cutting the bracing piles. The frame is supported on the upright piles. Details of the joint between the bracing piles & cap are shown on the same plate. The upright piles are cut off at 2" above mean low water, and then notched to receive the cross cap as shown on plate 23. Everything is now ready for setting the concrete block.

It being impracticable if not impossible to cut all the piles below the surface of the water to exactly the same height, & since the bottom of the concrete block is a rigid plane, it is evident they will only reason the three highest piles of those under them, until

some crushing or bending takes place. To obviate this a mattress of burlap containing freshly mixed soft mortar in a layer about 2" thick is placed on a network of marline stuff, supported by a plank frame about its edges & lowered upon the tops of these piles immediately before setting the block. A diver then cuts the netting between the edges of the mattress & the plank frame. The latter floats to the surface and is netted for future use. Chains are now passed through the hole and along the grooves in the base block, and it is hoisted and lowered into position by the 100-ton derrick and rests on the mattress of mortar. The action of this mattress is that, the mortar being enclosed in bagging preventing separation of sand and cement or water killing of the cement, when the weight of the base block comes upon it the excess of mortar is pressed out from between the head of the pile & the bottom of the base block until each pile has a well an evenly distributed portion to carry, & when the mortar hardens that part between

the piles acts as a continuous brace or tie for all the piles.

After the apron locks are set the vertical chain grooves in each block coming opposite to each other, are filled in with con-c. &c in bags, & well rammed into place. This closes the joints between the blocks, & also acts as a tongue set into the grooves of the blocks to prevent one block moving alone.

As soon as the blocks have been set the cross caps, resting on the upright piles & the longitudinal caps are placed in position & fastened with oak treenails, a wooden chock is placed on the top of the concrete block for this cap to rest on. Small cobbles are then filled in among the piles up to the level of the top of the cross cap as shown on plate 23. Rip rap is piled outside of the piles as shown on plate 22.

The granite facing is now begun and carried up to the coping. The granite masonry differs from that previously used in making the two lowest courses in one, of equal rise to the two. The advantage is that the course can be set at every low

time whereas formerly there was frequent delay & loss of time.

The concrete backing, (see plates 22 23a 23,24 & 26) is ~~carried~~ put in after the granite has been set. In order to give shape to the backing & enable it to be rammed while it is put in mold boards are constructed. The arrangement of these may be seen on plate 23 and 26. The backing is not brought up all at once to the level of the coping course but the work is done in steps, much as a rubble wall would be laid. Plate 26, drawn from actual measurements, shows how the work is left over, until a new section of the wall is ready to be backed with concrete. It will be seen that the following concrete backing will form a bond with the already hardened backing.

Rip rap is now filled in back of the wall to mean high water level as shown in Plates 22 & 23. The coping stones are set and the filling in at first to the top of the "E" course commenced. A stone key 21" x 5½"□ is set between each coping stone and the next, in notches cut in the stones,

for that purpose. The joints between the stones are grouted.

When the coping has been laid for an appreciable length the filling of sand & dirt is brought up to the level of the top of the coping course & the street is paved. See plate 22.

To prevent accidents to vehicles & wagons, ~~from~~ by backing into the river a square timber or sill 12" x 12" is laid upon the coping stones (See plate 22.) These timbers are fastened to the granite by bolts known as the Ahlstrom bolts. A drawing of one of these bolts is given on plate 31. They grasp the sides of the nib in the granite when screwed down, & thus holds the timbers very firmly.

Wherever a pier springs from the wall the coping course is ommitted. Sewers are let through holes built in the granite facing of the wall, and the concrete backing is filled around the sewer when completed. The sewer is built of brick where it penetrates the wall, but, as we shall see further on, it is of wood, where it runs between

the piles of the pier. Plate 29 shows the method of bringing a sewer whose direction is inclined to bulkhead line, through the wall. The same general method would be employed in bringing one through that was not inclined. Plate 30 shows the method in which the sewer is supported from the street to the wall.

It may not be out of place here to give the following considerations, which led to assigning some of the proportions of the wall. A depth of water along the quay of 20-22 feet at low tide is amply sufficient for the largest vessel likely to lie there & for small vessels 14 to 16 ft. The most convenient height of the quay above mean high water was thought by General McClellan to be 5 ft., which besides is sufficiently great to protect the river street against the highest floods. To answer all of the above requirements the height of wall should be 32 feet.

The concrete blocks for the wall are made at the Department yard foot of Sansevoort street. A firm platform is provided on a level with the street. On these the moulds are erected just as for forming the blocks for the first system.

The moulds are formed of removable wooden cheeks & back & front. A mold set up & ready for filling with concrete, & one in process of erection, is shown on plate 27. A being the side & C the front. The parts are fastened together with iron rods & nuts as shown on the plate. A core made up of sections, so it may be withdrawn after the block is completed, is placed inside the mould so as to form the grooves for the chains used in setting the block. The grooves in the block are shown on plate 28. On withdrawing the wedges B Plate 27 the the core collapses & it may be withdrawn on removing the cheeks.

The concrete is mixed in a bin & wheeled in borrows to the tops of the molds & thrown in, 2 men in the mould spread

the concrete is then kept 4" thick and then it is firmly rammed with beetles weighing from 50-60 lbs. After the concrete is brought up to a level with the top of the mould, another & smaller mould is placed on the back of the stone & the parallelipipedon projection or step A Plate 28 formed.

The proportions for making the concrete are: 1 barrel of portland cement weighing 375 lbs, 2 lbs sand, from Red Bank N.J. each weighing 300 lbs, and 5 lbs trap rock broken to 2" pieces each bbl. weighing 300 lbs. These amounts of each are brought to the proper consistency when mixed with 15 gallons of water. The concrete sets in 2½ hours & the stone is stripped 24 hours after it is finished. It may be transported in 6 days but is usually allowed to set 1 month. The stones weigh about 75 tons & have a specific gravity of about 2.5.

The proportions used for concrete baking are the same, except when laid in water, when the proption of 5 of stone is changed to 7.

The concrete base blocks, shown on plate 28, are of different size and shape than those used on any other work of this kind. The step on the rear extending the whole length of the block is for the purpose of giving the mass concrete backing of the superstructure a good hold upon the block.

As before stated, grooves for chains are moulded in the ends, to facilitate handling, & are connected by a longitudinal groove 2 feet above the bottom, so that there is no groove which should it come over the head of a pile, would prevent the pile from doing duty in supporting the block. The front is curved inwards to save material, while at the same time a broad base is obtained.

Wharves and Piers.

So much has already been said, with regard to the history & poor condition of the wharves piers & bulkheads of the City in former times, that little need be added here. I however propose to describe the early piers, & remedies which were suggested as well as the present system in detail.

The plan of constructing the early wharves, where hard bottom could be reached at ordinary depths, was by the "block & bridge" system, that is, of alternate cribs of wood filled with stone & bridgeways of from 20 feet span. Where holding ground for piles could be found, these were undoubtedly used. The piers were generally put up as the de-

mand for them proved the necessity; they were built by contract & done by the job, frequently in great haste and at an unfavorable season, without suitable examination of the bed of the river. Having been in almost all cases built across the current, scarcely a storm passed without doing serious damage to the corners ends & other parts of them. This no doubt was also due to their mode of construction, as they did not allow of the free passage of the current.

The committee that met in 1863, reported that the mode of building piers then in practice was very reprehensible & should at once be improved or the building of piers of wood at once abandoned. Further, that the immense masses of stone, used to form blocks generally at the outer ends of the piers were frequently scattered over the bed of the river by the collapsing of the wooden enclosures. They thus impeded the current to such an

extent that great deposits ensued, & the basins between the wharves were filled in many cases to such a degree that small vessels would not float where formerly it was very deep. Mr Wright stated in 1836, that ~~that~~ the supports of the piers occupied 5/8 of the waterway, thus seriously obstructing the current & occasioning deposites of mud between the cribs & in the slips. The wood composing the piers, was not preserved, it soon decayed & the debris from the wharves made navigation in the river dangerous & difficult.

As we have already seen, it was early suggested to remedy the difficulty of obtaining good & sufficient wharf accomodations, by erecting a great pier or mole in the Hudson River. This mode of solving the wharf question was, for a long time a favorite one, a description therefore, of the mole, will not be amiss.

It was proposed by the committee that met in 1836, to suspend the building of any or but few, small piers from

the island, & in lieu thereof to erect in the North river a stone island or quay to be called the Great West Pier, & to extend in due time from south Battery northerly to Kings Bridge or as far as required. It was to be built 800-1000 feet beyond the west end of the present wharves. To be constructed without the use of coffer dams, & diving bells to be used only in the first 5 or 6 feet immediately below low water. To be connected to the mainland by wharves or bridges each 250 feet wide & built of timbers. Thus dividing the water between the city & the pier into several basins. The wharves were to have walks & under these sewers were to be placed, so that the filth of the city might be carried beyond the pier into the river & bay. On each side of the walk there was to be a carway for vehicles, 50 ft wide. There will be draws in such bridges as may be found necessary, and such openings across the pier into the river, as may be thought best. The pier was to

be 200 feet across 5 feet above high water & provided with a cellar throughout the whole length & capable of affording lots 25 x 100 on which storehouses could be built. These latter it was thought might be a source of revenue to the city.

The pier was to be constructed with stones weighing from ¼-4 or 5 tons, thrown in promiscuously until made up level with low water. Through the openings at the upper & lower ends of the basins as well as between the piles of the bridges, it was thought, flood & ebb tide would have a free passage, thereby preventing deposits of filth & mud.

The idea of providing wet basins for New York City, was obtained from the practice in England. The idea is altogether a false one because the conditions are entirely different in the harbor of New York from what they are either at Liverpool or London. To erect a breakwater & basin in the Hudson river would only be to impede the current, & all the consequences, which have already been mentioned, would

follow. No breakwaters are necessary, because ships may be sufficiently protected by good wharves.

In England where the rise & fall of the tide is 15 feet wet basins, provided with locks are an absolute necessity. The disadvantage of being obliged to use them is admitted by all, for ships can only enter & leave the basin, for a short time before, during, & a short time after high tide.

The slight rise & fall of tide in the harbor of New York is one of its great natural advantages, & not to take advantage of this, is to ~~lost~~ seek difficulties where they do not exist.

The absence of such constructions from the port of New York makes it appear, by comparison but poorly provided for, when in fact, a very simple & inexpensive class of structure, can afford the facilities offered by the expensive constructions of the Old World. This is actually the case at the present time.

The mole purchased in 1836 was never constructed, though it

was recommended by every committee that met to consider the improvement of the water front, up to orginization of the Department of Docks.

In 1863 a Committee on Wharves & Piers met, for considering the advisability of substituting stone in lieu of wood in the erection of wharves & piers. The committee in 1936 had thought of erecting stone piers but came to the conclusion that it was too expensive.

The committe in 1863, were brought to consider the question of stone piers, from the fact that the wooden piers were giving so much trouble, in impeding the current, causing deposits, and on account of their decaying so rapidly.

It was urged that stone piers could be built in arches and so the current would not be interfered with & deposits would not be formed in the slips.

The following are some of the advantages of stone piers as set forth;

Although the stone piers cost much more to build originally than would be required to construct wooden ones, nevertheless their indestructability, its saving hundreds of thousands of dollars annually, now expended in repairs & the fact that no impediment will be placed in the way of the safe navigation of the water surrounding the city, by the accretion or deposit formed around the obstructions caused by the decaying piles & timbers & collapsed blocks or cribs, is of itself a consideration far beyond the cost of its construction.

From a sanitary point of view stone piers were said to be a great advantage. Sewers could then be extended to the front of the piers & sewage could then be carried out of the way by the currents. It was said that this was impossible or impracticable in piers built of piles. This however is not so, for as we shall see, it is done on the piers now being erected.

The committee further proposed to order at once the construction of 2 stone piers one in the North & one in the East river with a view of practically testing their advantages & ascertaining by actual experiment the cost of such undertakings in order to apply the information thus obtained by practice to the theory of substituting stone in lieu of wood in the erection of all the piers.

Their proposal was never carried into effect, but a stone pier has been since erected in the Hudson River & from this we can draw conclusions as to the practicability of stone piers for New York City. The pier was commenced in 1871 & completed in 1875. The pier is composed of 20 full center arches each of 20 feet span. The arches are supported by monolithic blocks of concrete made to exact dimensions by ramming the material in strong wooden moulds. The dimensions of the pier are; 500 in length 80 feet in width, height of roadway above mean high water

5 A.

The objections to stone piers are, that they take a long time to build, & it is difficult to obtain foundations for the piers when the mud on the river bottom is deep, which is the case as may be seen from the sections on plate 17. Another objection is the great first cost, for although a stone pier lasts forever it must not be forgotten that it does not command a higher rent than a good wooden one, & the interest on the capital invested is more than would be necessary to rebuild a wooden pier every 10 years. The advantage that sewers may be conducted to the end of stone piers, is no point in favor of them, for this can also be done in wooden piers properly constructed, & such piers do not ~~cons~~ obstruct the current to any greater extent than stone ones.

It has therefor been decided not to construct stone piers, but to construct wooden piers in the best manner possible & with all the necessary precautions. Such have been in

process of construction since 1871 and have ~~unfulfilled~~ fulfilled all the conditions imposed upon them.

It was suggested to the Committee appointed by the Senate in 1866, that all new piers should be built & old ones in time rebuilt, supported on iron columns & in such a substantial manner that the flow of the tide should not be interfered with & that storehouses should be erected on them.

This plan has been substantially followed by the Department of Docks, as being the best system, with the exception that piles are used instead of iron columns, as it is found cheaper in the end.

The general system of improvement adopted in 1871 is, really the same which the necessities of the past had already established even as far back as 1728, & it is surprising that it had not been carried out earlier, namely a system of narrow wharves & slips affording the largest wharf & quay line for the shortest extent of water frontage, combined

with readiness of access.

As before stated the street is distinct from the wharves, the former being for the use of the whole community, the latter for shipping interests alone, & of course shipping interests should therefore pay for the latter.

The problem now to be solved is: of the various systems of wharf construction affording equal facilities for the transhipment of freight which will be the most economical for commerce. Cheap wharves of short durability, requiring frequent rebuilding or more expensive ones of great durability. Further shall they be of stone iron or wood.

The question may be more concisely stated thus: Given the cost & lives of various wharves, all satisfying the engineering requirements of strength & stability & affording the same facilities, to determine which involves the least outlay for its maintenance. It has been found by comparing the various types of wharves, that

in a very large ratio the wooden structures are more economical than the others. It also appears that if the wood could be artificially preserved, at about 25 cts per cu. ft, so as to last 35 years, the structure would prove cheaper than those constructed of natural wood.

The piers are now being constructed, with few exceptions of natural wood. Plates 32-47 show plans, elevations sections & details for the new pier 60 feet of 30th Street Hudson River, which is being constructed at this writing.

The site of the pier as well as the slip is first dredged to 25 feet below mean low water. The piles are then driven commencing at the bulkhead end of the pier. The piles are from 75-85 feet in length, they should not be less than 8" diameter at the point nor less than 15" at the butt end.

Each vertical pile is driven with a pile driver, the hammer of which weighs 2,500 lbs having a concave face & with an effective fall of 10 feet. The piles are driven

to hard bottom, or until the last 10 blows of the rammer, will not drive the pile more than a foot.

The pier in this case is 502 ft 6 inches long by 60 feet in width. The arrangement & spacing of the piles, which are of yellow pine, is shown on plates 32 & 33. After driving each pile it is staylathed to the one next to it to keep it in position. While the outer rows of piles are still being driven, tenons for cross caps, longitudinal & transverse are cut upon the piles already driven. The tenons are 7" long 3½" wide & 3 inches high.

The longitudinal & transverse caps are 12"×12". Longitudinal caps are first put on the outside rows of piles, which are cut lower down, so that the transverse caps, mortised to the transverse rows of piles, may rest on these longitudinal caps. This arrangement is clearly shown on plate 34. Before putting on the cross caps the tops of the piles & the tenons are painted

over with dead oil. Plate 36 shows details of the scarf joints used for the transverse & longitudinal caps.

Each cross cap is fastened to the longitudinal cap & to the pile upon which it rests with one 7/8" square & 22 in long spike, holes being driven for the spikes.

In order to strengthen the pier transversly, bracing piles, inclined to the vetical piles, are driven. There is a bracing pile for each row of transverse pile, but they are placed alternately on the north & south side of the pier. The 8 outermost rows have a bracing pile both on the north & south sides of the pier in order to give extra strength to this part. The arrangement of these bracing piles is shown on plate 33, & details on plate 34.

Each of the forty transverse rows of piles, beginning at the sixth row from the bulkhead wall, are further braced on the easterly side of the rows, with horizontal & "A" braces of 5" & 10" yellow pine plank. This bracing is

shown on plate 34.

Nine rows of interior girders are placed on the cross caps, & a long side girder on the north & south side of the piers. These girders are shown in place on plate 33. They are of yellow pine & 12"x12" in section & of lengths of about 36'8". The pieces are joined with butt joints & fastened with fish plates. The details of this joint are shown on plate 36.

The deck of the pier is now put on. It consists of 4" yellow pine plank, laid parallel to the cross caps, with 4" spaces between the streaks, as in plate 33. Over the whole area of the pier a sheathing of spruce plank 3" thick, is laid close, at an angle of about 45° with the center line of the pier. (See plate 33)

The surface of the deck is freely treated with "Dead Oil" before the sheathing is put on.

Plate 40, 42 show details of bolts used in fish joints & for fastening the horizontal & "A" braces to the piles.

The outer end of the pier is provided with two mooring posts of cast iron resting upon foundations of 12" x 14" timber, over the intersection of the second girder on either side of the pier with the second cross cap from the end. (see plates 37 + 39) There are 8 additional mooring posts (plates 38 + 39) of cast iron on each side of the pier as shown in the plates. The strap bolts etc for fastening the mooring posts down are shown on plate 41.

The ends of each of the 8 rows of piles at the outer end of the pier are protected against the effects of ice by armatures of boiler plate ½" thick, extending about 7'2" down from the under side of the longitudinal cap + about 4'1" along the planking on the westerly side of the rows, + embracing the additional piles at each end of the rows. The armature plates are shown in detail on plate 35, + in position on plate 32.

Wooden fenders are placed outside of each outside pile

of the pier, including the additional piles at the outer end of the pier. These fenders are shown on plates 32 & 34. At the end of the pier there is a sheathing as shown in the end Elevation plate 32.

The sewer is an oval wooden box of the size & shape shown on plate 34, ~~plate~~ which also shows its position in the pier. It is built of 3"x4" spruce or yellow pine timber, free from wind shakes, decay, loose & rotten knots etc. The sewer is built in sections about 18'4" long, & each section is held in shape by 6 galvanized iron bands 2½ inches wide, fastened by screw bolts. (see plate 45) At the butt joints between the sections there will be cover bands, plate 45, of galvanized iron 5 inches wide, fastened with screw bolts.

The sewer will be supported by sewer beams on the transverse rows of vertical piles easterly of the outer 8 rows, by the horizontal braces, & by the horizontal planking on the 8 rows rows of piles at the outer end of

the pier. See plates 33, 34, 43, 44. At their centres these sewer beams will be cut out on top to a depth of about 7" to the true curve of the bottom of the sewer, to give it a firm & true bearing. Plate 34.

The end of the sewer opens into the river by a galvanized iron mouthpiece as shown on plates 43+46.

Where it is necessary, on account of the nature & value of the goods landed, the wharf is covered with a shed. The crossection and elevation of a standard shed is shown on plate 47. The inclined sides facilitate the unloading of goods, as the ship is thus enabled to approach closer to the wharf.

Experiments have been tried of using a double decked wharf, so that goods might be unloaded on to one of the decks while they were being removed from the other. The plan however has not yet come into general use.

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Concrete backing on bulkhead wall.	26.
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Concrete base blocks (details).	28.
Sewer outlet thro' bulkhead wall.	29.
Support of sewer on piles.	30.
Ahlstrom bolt.	31.
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" " " " " " " (showing sewer).	33.
Cross sections of Pier 60 with details of sewer etc.	34.
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End mooring post.	37.
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Strap bolts & mooring post bolts.	41.
Bolts, nuts, & washers.	42.

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A Plan of the City of NEW YORK from an actual Survey
Made by James Lyne
Plate 1
To His Excellency
JOHN MONTGOMERIE Esq
Capt Genl & Govr in Chief
of his Majesties Province
of NEW YORK NEW JERSEY
&c
This Plan of the City of
NEW YORK is humbly Dedic
by Your Excellency's Obed
& most humble Servt
Wm Bradford
A Kings Chappel built 1694
B Trinity Church built
C Old Dutch Church
D French Church
E New Dutch Church
F Presbyterian Meeting
G Quakers Meeting
H Baptist Meeting
I Lutheran Church
K Jews Synagogue
1 Govr House
2 Secretaries Office
3 Custom House
4 Weigh House
5 City Hall
6 Byards Sugar House
7 Exchange
8 Fish Market
9 Old Slip Market
10 Meat Market
11 Fly Market
A Scale of Feet 660 Foot
One 8th of a Mile
Col. Robt Lurting
MAYOR
1728
North River
Kings Farm
Bowling Green
Garden
COMMON
High Road to Boston
Beekmans Swamp
Broad Way
Harbour
Hunters Key
Burnet's Key
Hanover Square
White Hall
Cherry Street
Queen Street
William Street
Smith Street
Broad Street
Beaver Street
Dock Street
Wall Street
Crown Street
Maiden Lane
John Street
Nassau Street
Kings Street
Cliff Street
Golden Hill
Princes Street
Garden Street
Stone Street
Bridge Street
Pearl Street
Parade
Duke Street
Mill Street
Rope Walk
Meadow
Swamp
WEST WARD
NORTH WARD
SOUTH WARD
DOCK WARD
EAST WARD
MONTGOMERIE'S WARD
W. Dock
E. Dock

1860
Scale
Dyckman
FORT WASHINGTON
TRINITY CHURCH CEMETERY
MANHATTANVILLE
HIGHBRIDGEVILLE
CLAREMONT
WEST MORRISANIA
MORRISANIA
TREMONT
FORDHAM
MOTT HAVEN
HARLEM RIVER
HUDSON RIVER
NEW RESERVOIR
BLACKWELL'S ISLAND
NEW YORK
EAST RIVER

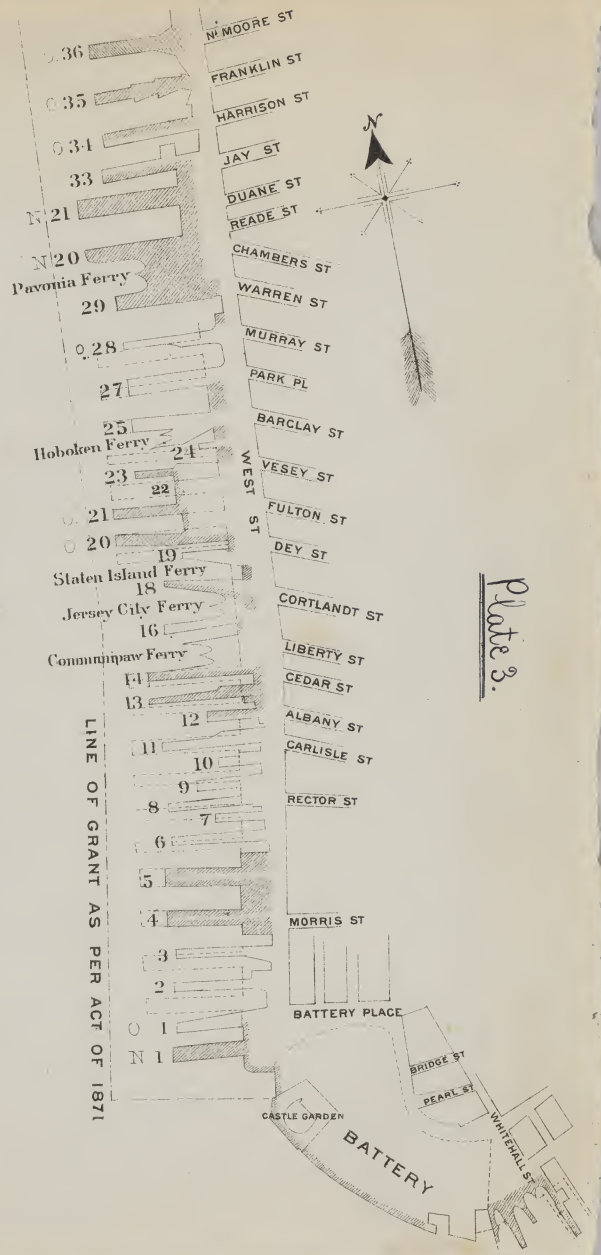
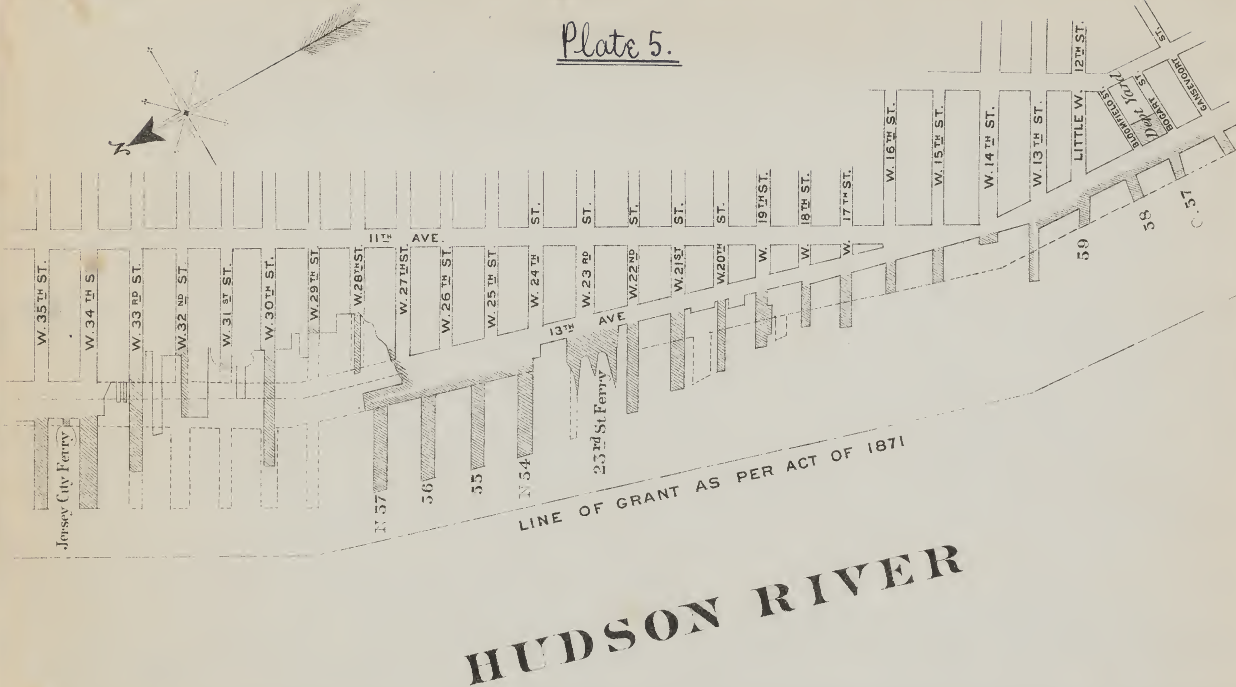

HUDSON RIVER
LINE OF GRANT AS PER ACT OF 1871
WEST ST
N. MOORE ST
FRANKLIN ST
HARRISON ST
JAY ST
DUANE ST
READE ST
CHAMBERS ST
WARREN ST
MURRAY ST
PARK PL
BARCLAY ST
VESEY ST
FULTON ST
DEY ST
CORTLANDT ST
LIBERTY ST
CEDAR ST
ALBANY ST
CARLISLE ST
RECTOR ST
MORRIS ST
BATTERY PLACE
BRIDGE ST
PEARL ST
WHITEHALL ST
CASTLE GARDEN
BATTERY
Pavonia Ferry
Hoboken Ferry
Staten Island Ferry
Jersey City Ferry
Communipaw Ferry
36
35
34
33
N 21
N 20
29
28
27
25
24
23
22
21
20
19
18
16
14
13
12
11
10
9
8
7
6
5
4
3
2
1
N 1
N
Plate 3.


Plate 4.
N
ST.
WEST ST.
PERRY ST.
CHARLES ST.
W. 10TH ST.
CHRISTOPHER ST.
BARROW ST.
MORTON ST.
LEROY ST.
CLARKSON
W. HOUSTON ST.
KING ST.
CHARLTON ST.
SPRING ST.
CANAL ST.
WATTS ST.
DESBROSSES ST.
VESTRY ST.
LAIGHT ST.
HUBERT ST.
BEACH ST.
N. MOORE ST.
CAISSON
HORATIO
JANE
W. 12TH
BETHUNE
BANK
W. 11TH
13TH AVE
Bulkhead and Pier line 1871
Bulkhead line
Christopher St Ferry
Jersey City Ferry
LINE OF GRANT AS PER ACT OF 1871
HUDSON RIVER

Plate 5.


W. 35TH ST.
W. 34 TH S
W. 33 RD ST.
W. 32 ND ST.
W. 31 ST ST.
W. 30TH ST.
W. 29TH ST
W. 28TH ST.
W. 27TH ST.
W. 26 TH ST
W. 25 TH ST
W. 24TH ST.
W. 23 RD ST.
W. 22ND ST.
W. 21ST ST.
W. 20TH ST.
W. 19TH ST.
W. 18TH ST.
W. 17TH ST.
W. 16TH ST.
W. 15TH ST.
W. 14TH ST.
W. 13TH ST.
LITTLE W. 12TH ST.
BLOOMFIELD ST.
BOGART ST.
GANSEVOORT ST.
Dept Yard
11TH AVE.
13TH AVE
Jersey City Ferry
23rd St Ferry
N 57
56
55
N 54
59
58
57
LINE OF GRANT AS PER ACT OF 1871
HUDSON RIVER

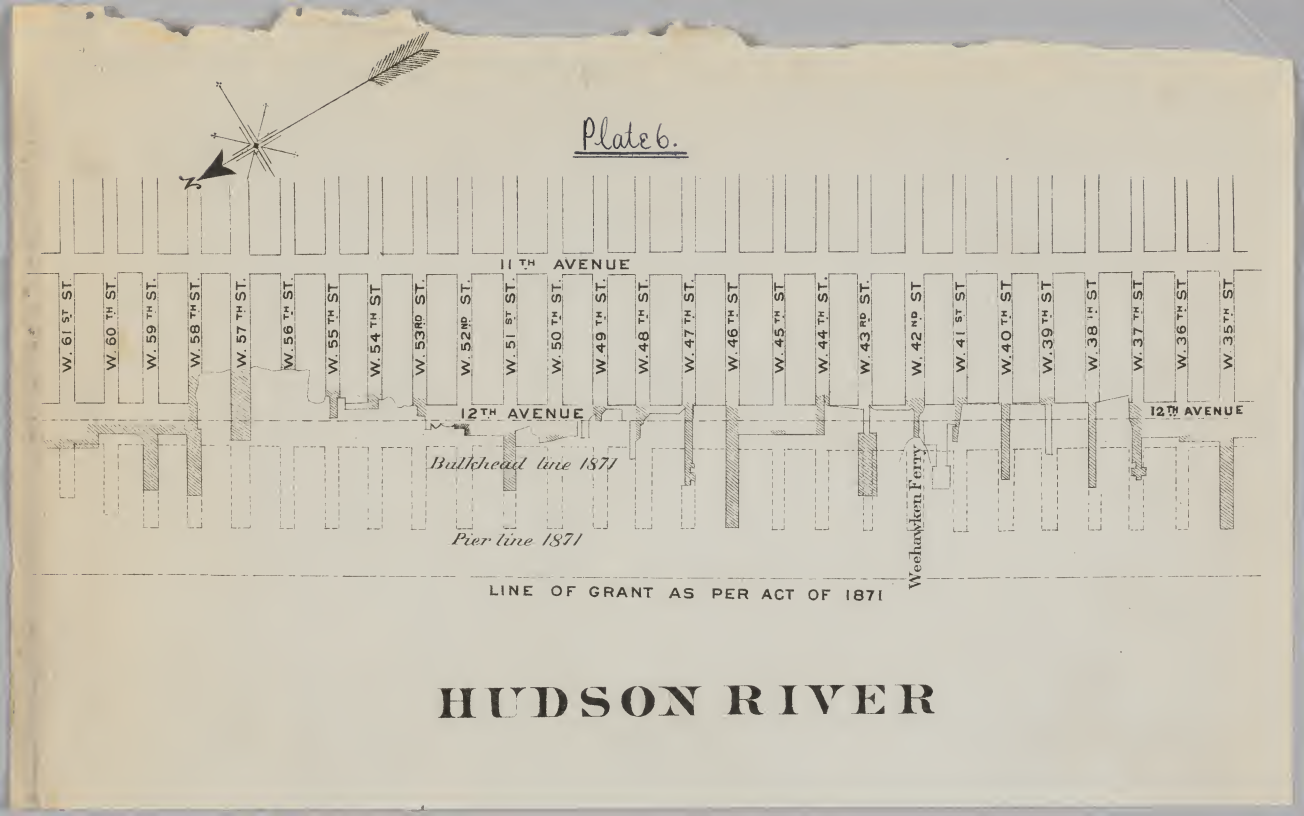
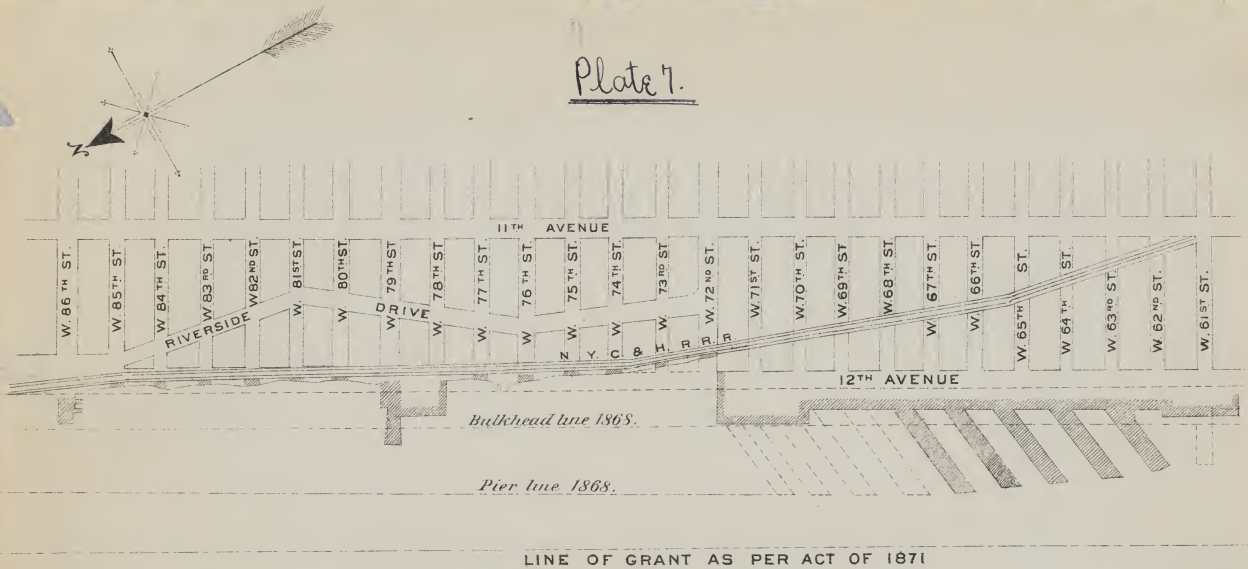


Plate 6.
11TH AVENUE
W. 61 ST ST
W. 60 TH ST
W. 59 TH ST
W. 58 TH ST
W. 57 TH ST
W. 56 TH ST
W. 55 TH ST
W. 54 TH ST
W. 53RD ST
W. 52ND ST
W. 51 ST ST
W. 50 TH ST
W. 49 TH ST
W. 48 TH ST
W. 47 TH ST
W. 46 TH ST
W. 45 TH ST
W. 44 TH ST
W. 43 RD ST
W. 42 ND ST
W. 41 ST ST
W. 40 TH ST
W. 39 TH ST
W. 38 TH ST
W. 37 TH ST
W. 36 TH ST
W 35TH ST
12TH AVENUE
12TH AVENUE
Bulkhead line 1871
Pier line 1871
Weehawken Ferry
LINE OF GRANT AS PER ACT OF 1871
HUDSON RIVER

Plate 7.



Note:
Hatched portion show Corporation Property
Unhatched " are claimed by private parties

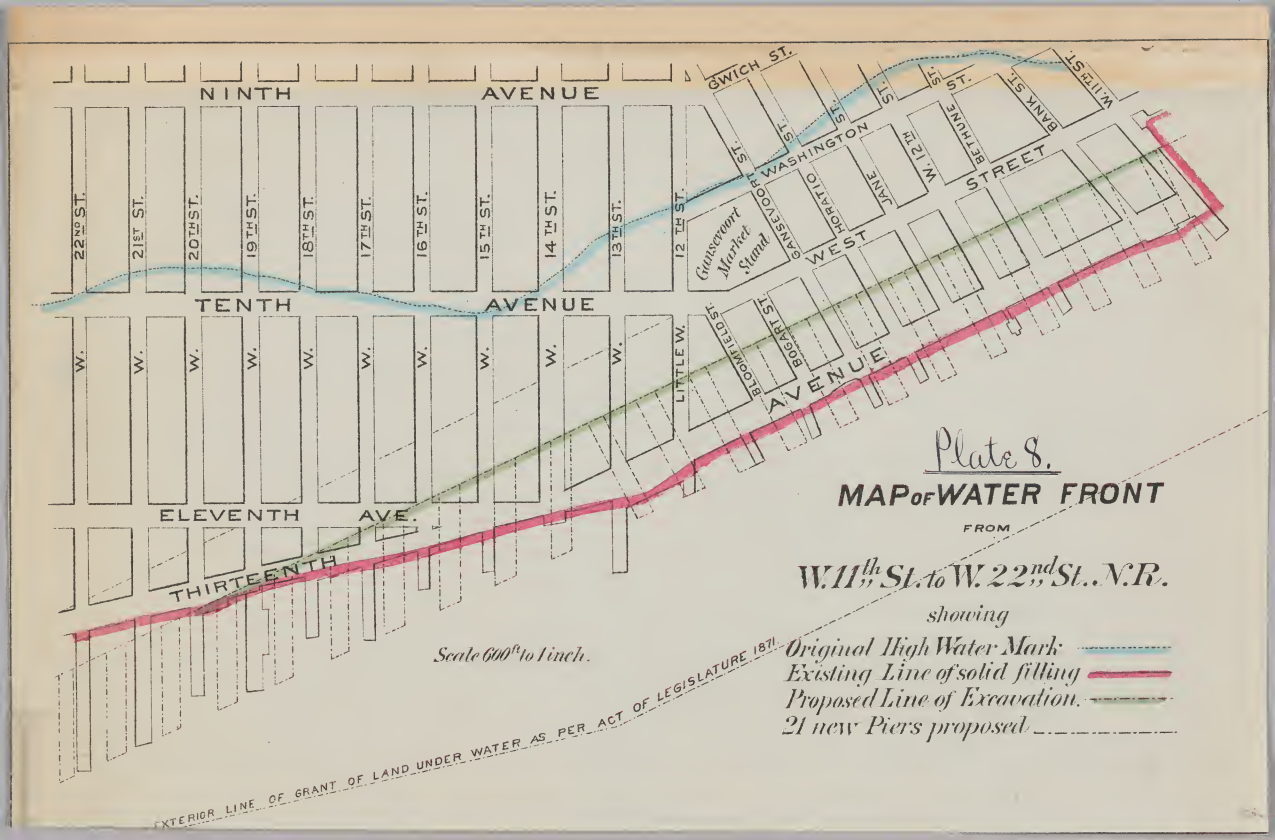
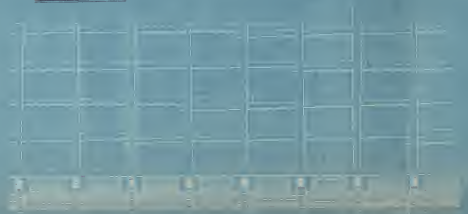

NINTH AVENUE
TENTH AVENUE
ELEVENTH AVE.
THIRTEENTH
22ND ST.
21ST ST.
20TH ST.
19TH ST.
18TH ST.
17TH ST.
16TH ST.
15TH ST.
14TH ST.
13TH ST.
12TH ST.
GWICH ST.
WASHINGTON ST.
GANSEVOORT ST.
HORATIO ST.
JANE ST.
W. 12TH ST.
BETHUNE ST.
BANK ST.
WITTS ST.
WEST STREET
Gansevoort Market Stand
BLOOMFIELD ST.
BOGART ST.
LITTLE W. 12TH ST.
AVENUE
Plate 8.
MAP OF WATER FRONT
FROM
W. 11th St. to W. 22nd St., N.R.
showing
Original High Water Mark
Existing Line of solid filling
Proposed Line of Excavation.
21 new Piers proposed
Scale 600ft to 1 inch.
EXTERIOR LINE OF GRANT OF LAND UNDER WATER AS PER ACT OF LEGISLATURE 1871

Plate 9

Plan



Scale ½ inch = 1 ft.

Front Elevation

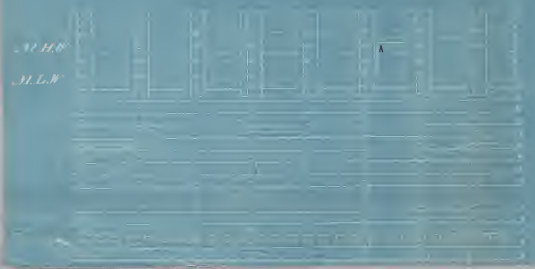


Plate 10.

W. 59th St.

N. York Central & Hudson River R.R.

12th Avenue

LOCATION

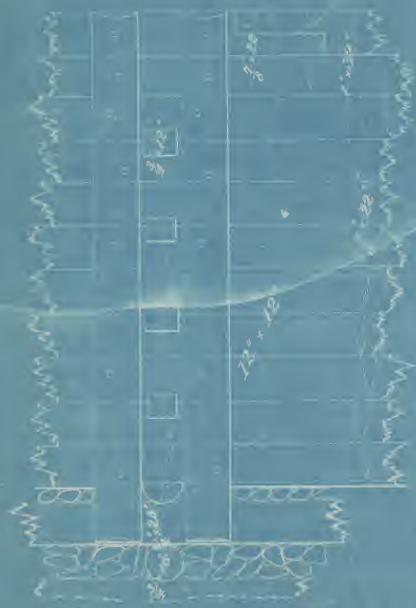
Scale 50 - 1

Cross Section

Elevation of Return

Scale 1/2 in.

Plate II.



Cross section of Drain

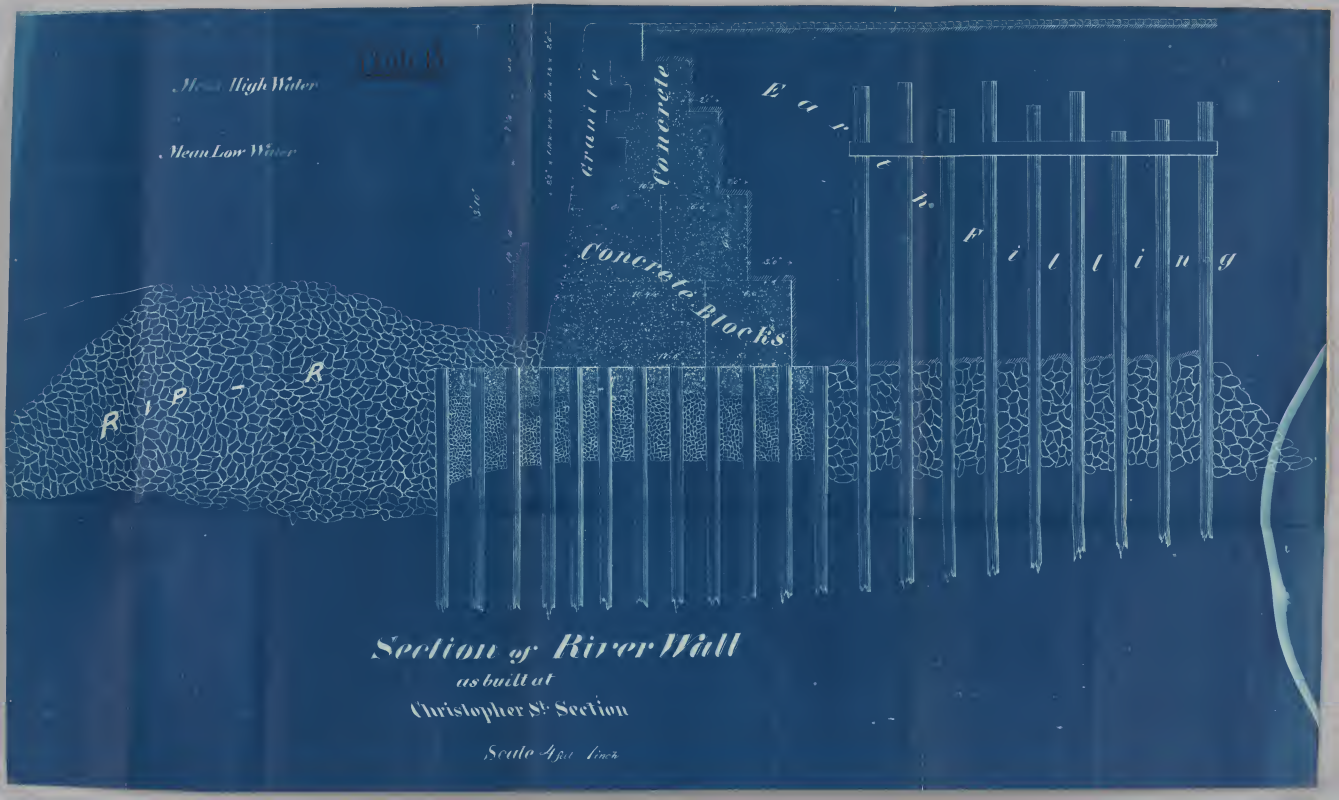
Plate 12.

Elevation & Section of Drain

Scale ½" = 1'

Crib Bulkhead from

Plate B



Section of River Wall

as built at

Christopher St. Section

Scale 4 feet 1 inch

put broken stone, trap or granite, in cubes of not over two

Plate 14

THE NEW DOCKAGE, NEW-YORK CITY.—MANUFACTURE OF THE CONCRETE BLOCKS.

Plate 15.

Borings on Proposed Bulkhead to Rock.

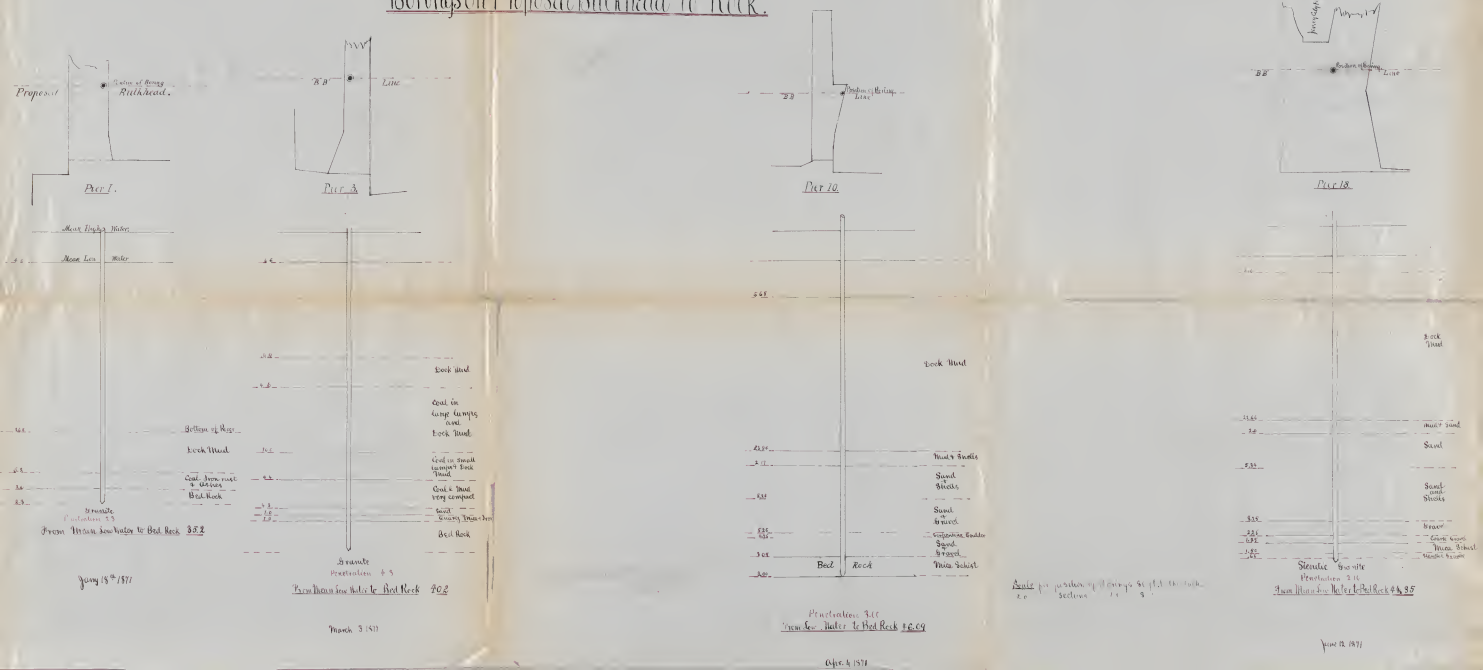


Plate 16

Borings along Bulkhead Line.

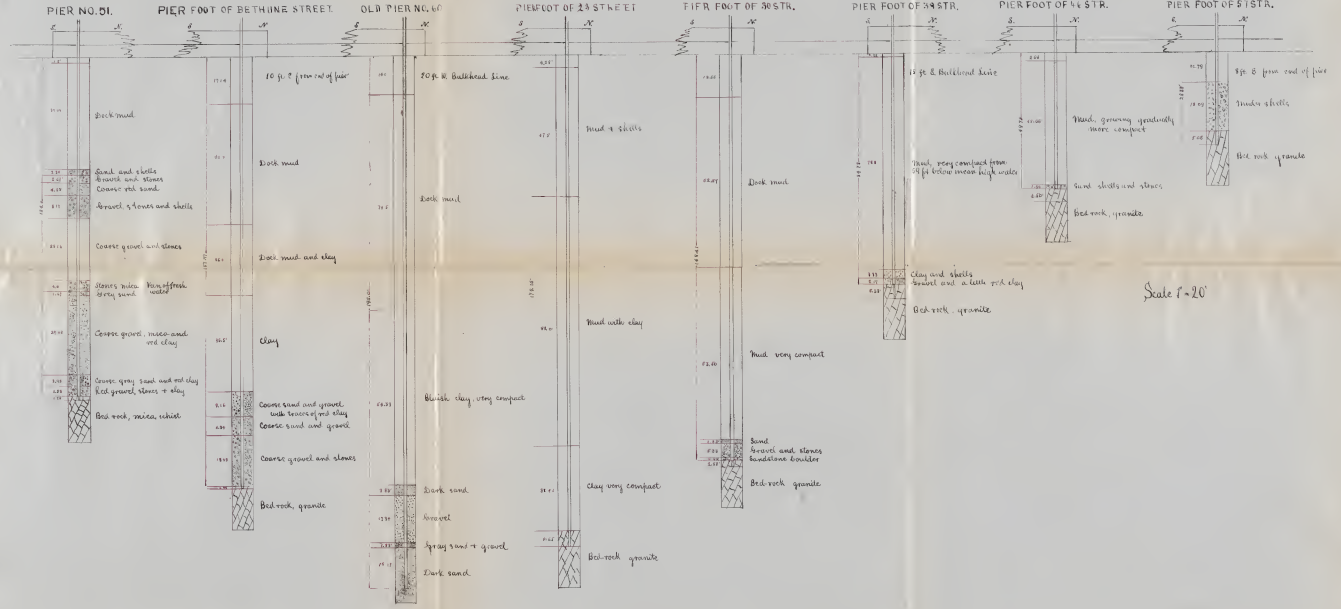
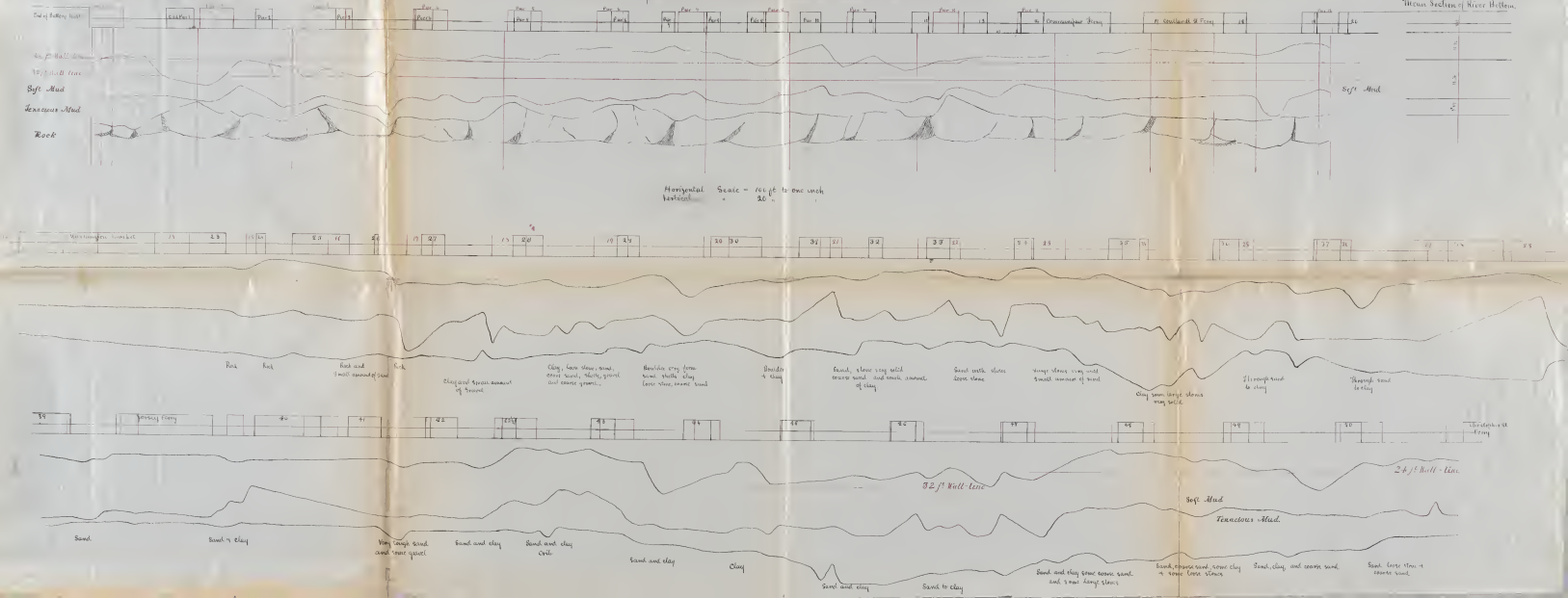


Plate VI.

Section of River Bottom on Buckhead Line.

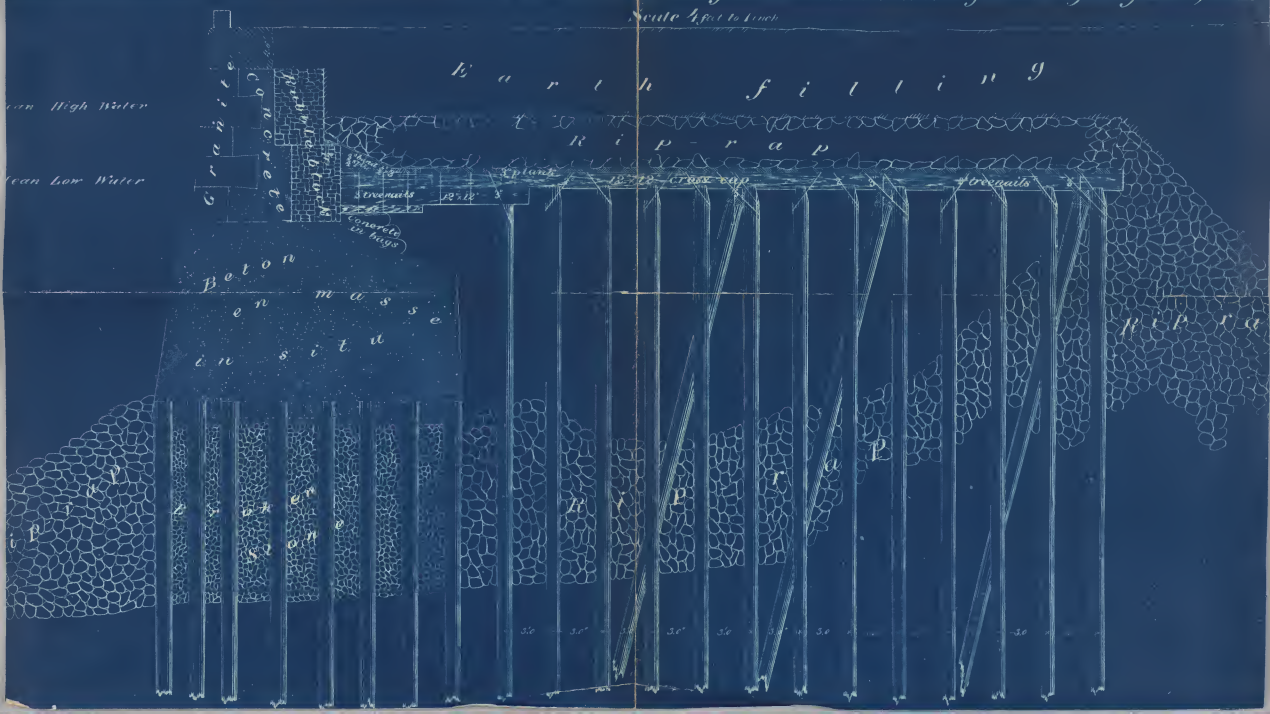


Horizontal Scale = 164 ft to one inch
Vertical " = 20 "

Plate 18

Section of Bulkhead Wall as built at Canal St. Section, North River, with Platform as recommended by Board of Engineers, 1876.

Scale 4 feet to 1 inch.



Sections of Bulkhead Wall
between
Old Piers 47 and 48. North River.

Scale: 1/4 inch = 1 foot

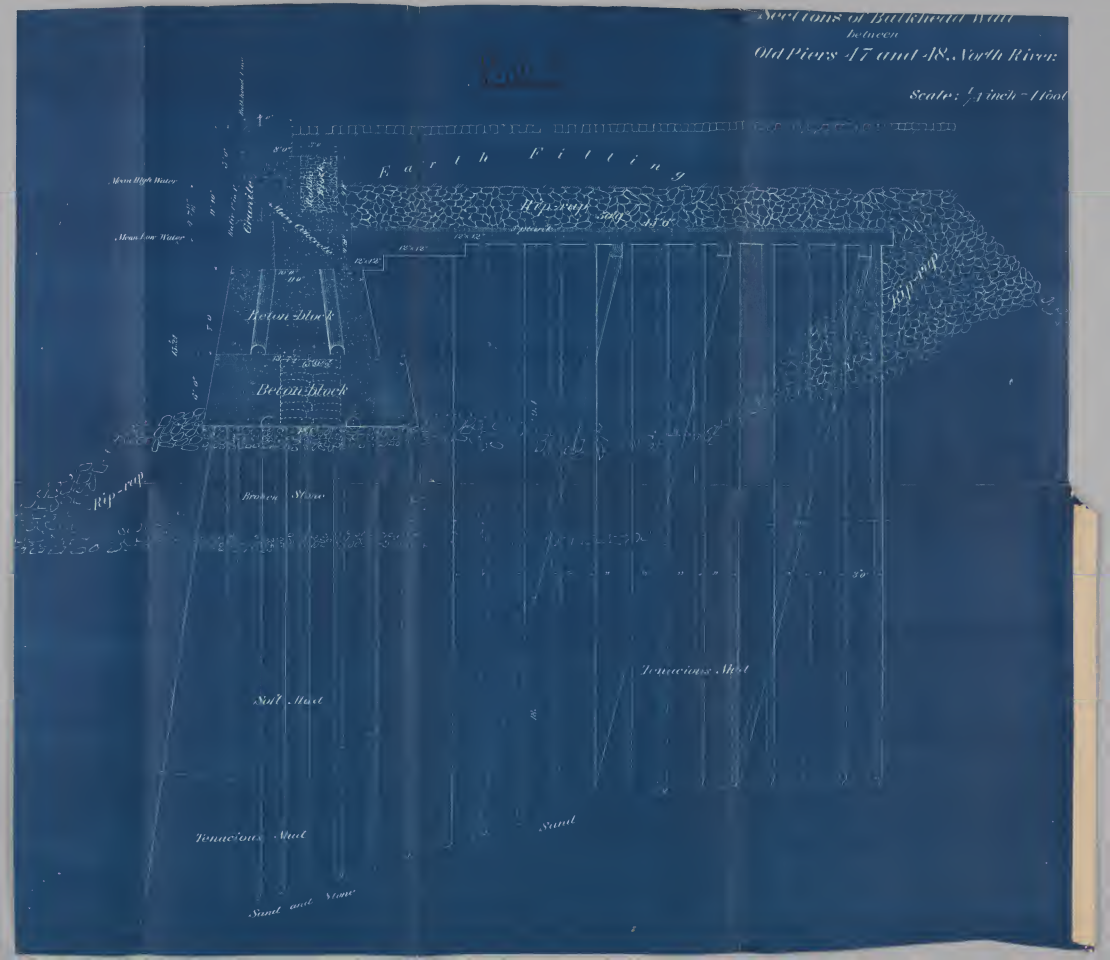
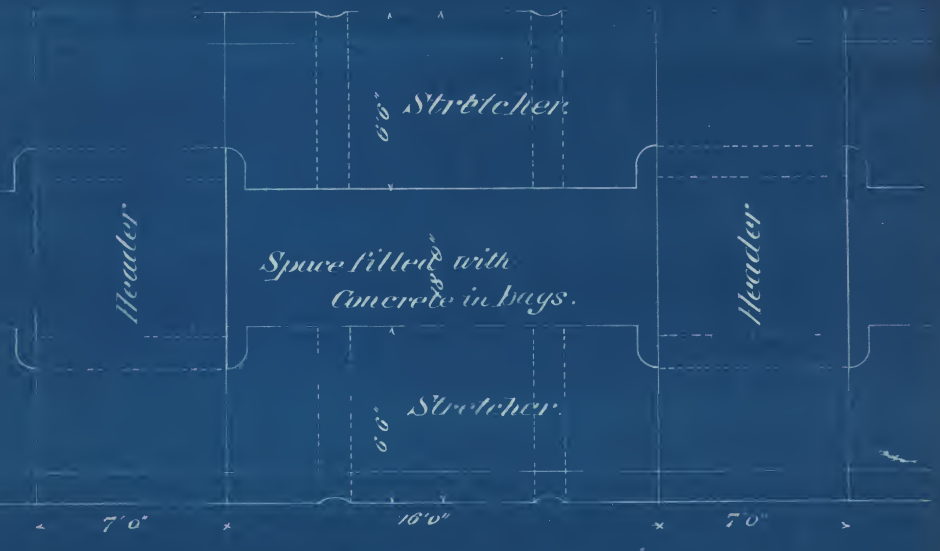


Plate II

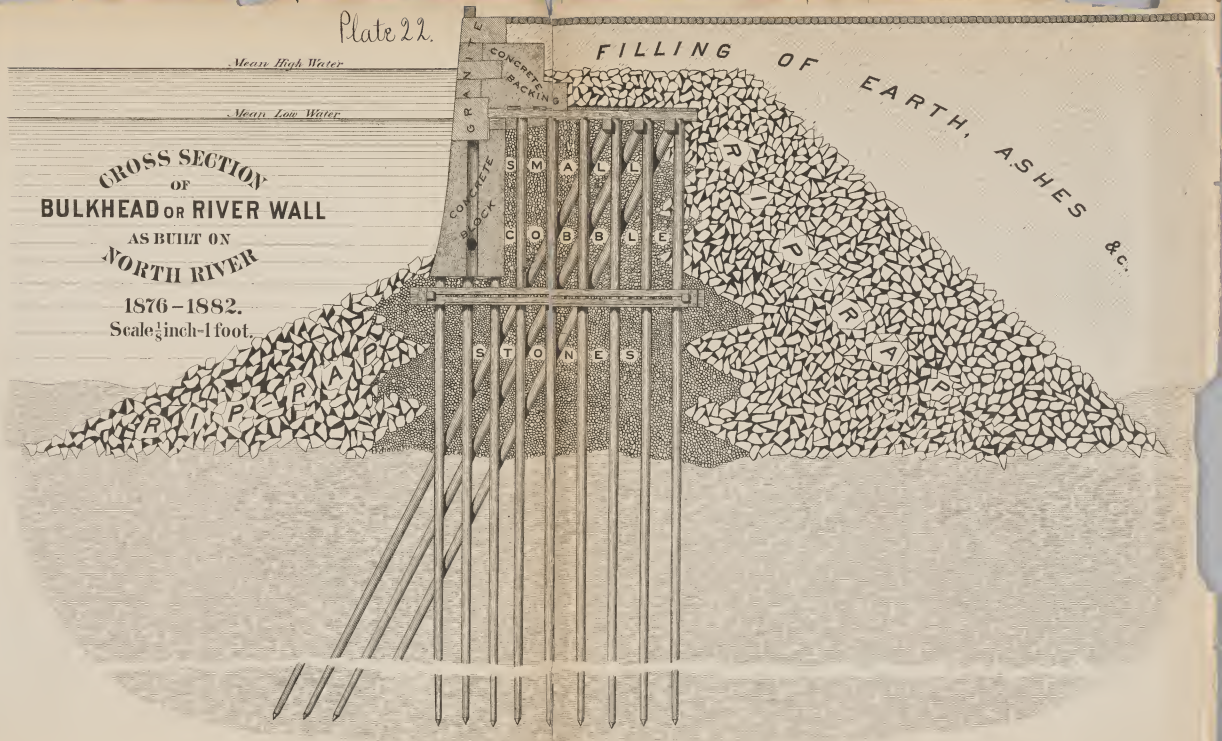
Arrangement of Beton-blocks in lower course.

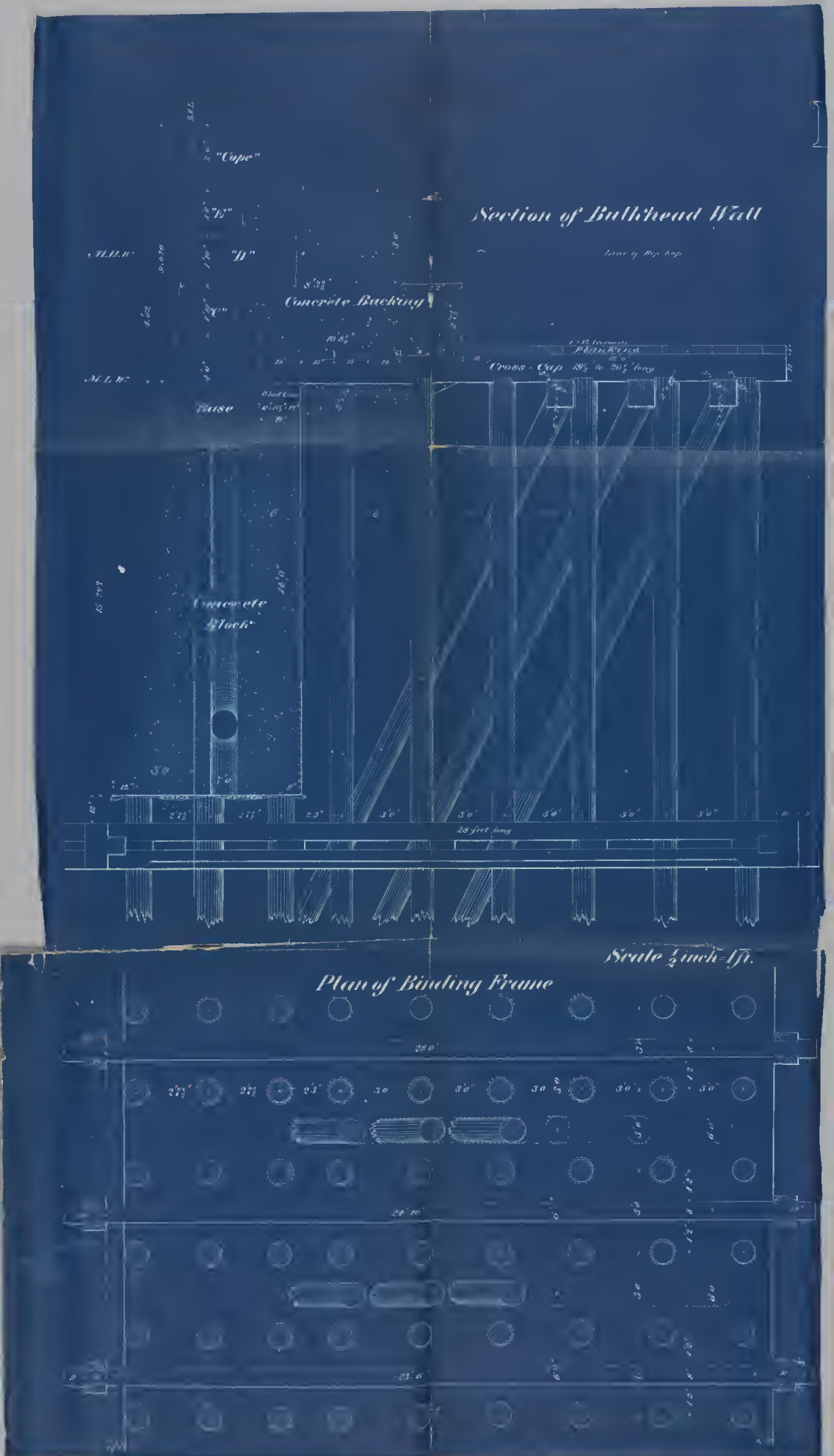


CROSS-SECTION OF THE BULKHEAD WALL
as built at
MORTON ST. SECTION

Scale 1" = 4 feet.

Plate 22.


Mean High Water
Mean Low Water
CROSS SECTION
OF
BULKHEAD OR RIVER WALL
AS BUILT ON
NORTH RIVER
1876 – 1882.
Scale 1/8 inch-1 foot.
GRANITE
CONCRETE BACKING
CONCRETE BLOCK
SMALL COBBLE STONES
RIP-RAP
FILLING OF EARTH, ASHES &c.
RIP-RAP
RIP-RAP


"Cope"
"E"
"D"
Section of Bulkhead Wall
Concrete Backing
Cross-Cap 19½ to 20½ long
Base
Concrete Block
23 feet long
Scale ½ inch = 1ft.
Plan of Binding Frame

Elevation

Plate 23a.

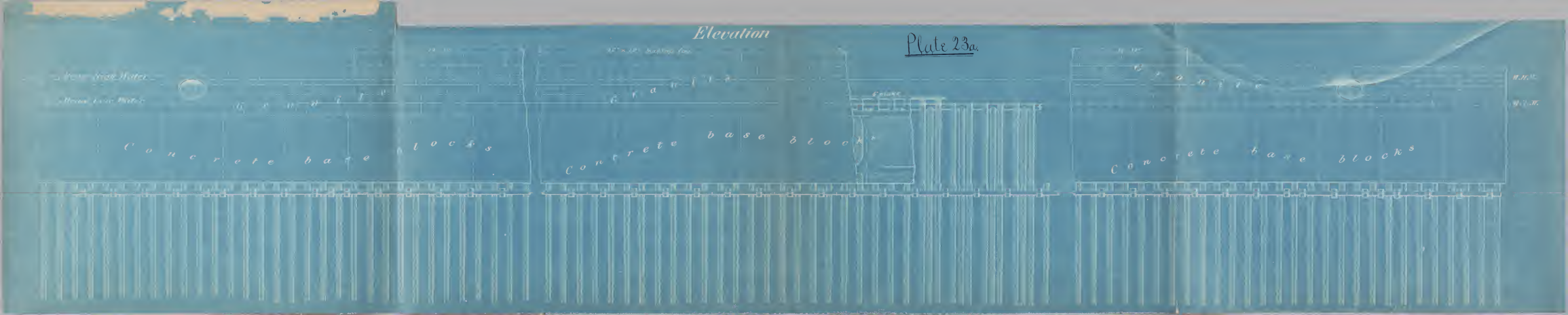
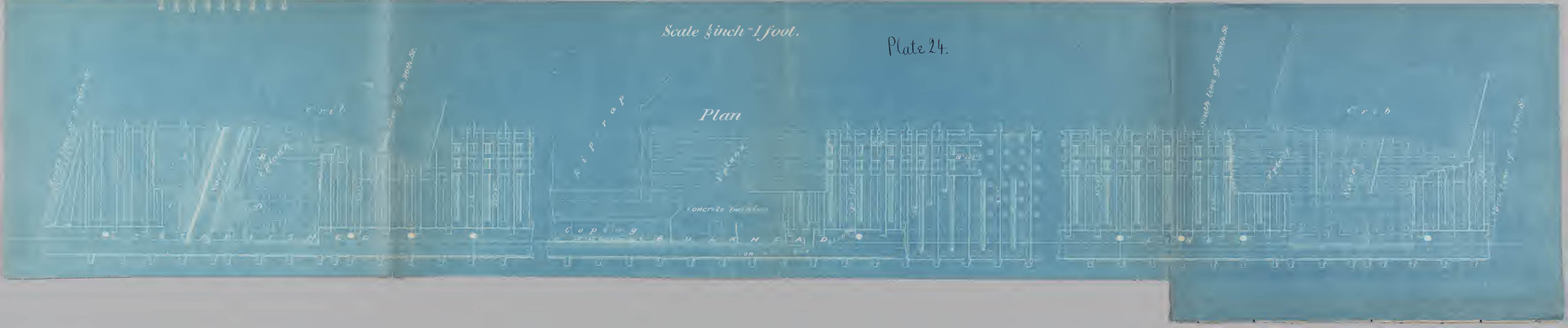
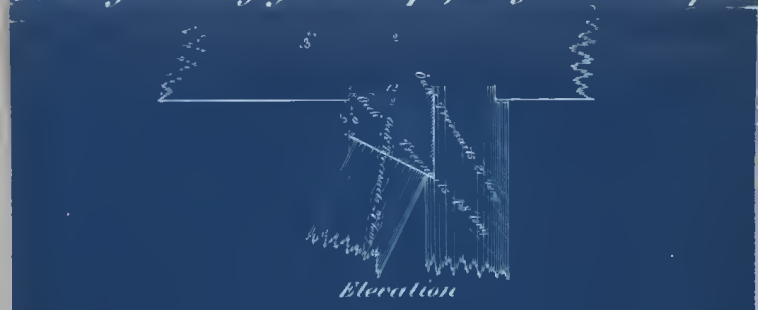


Plate 24.



Saw Frame for Batter Piles

Detail of Crossing of Cross cap & Longitudinal cap

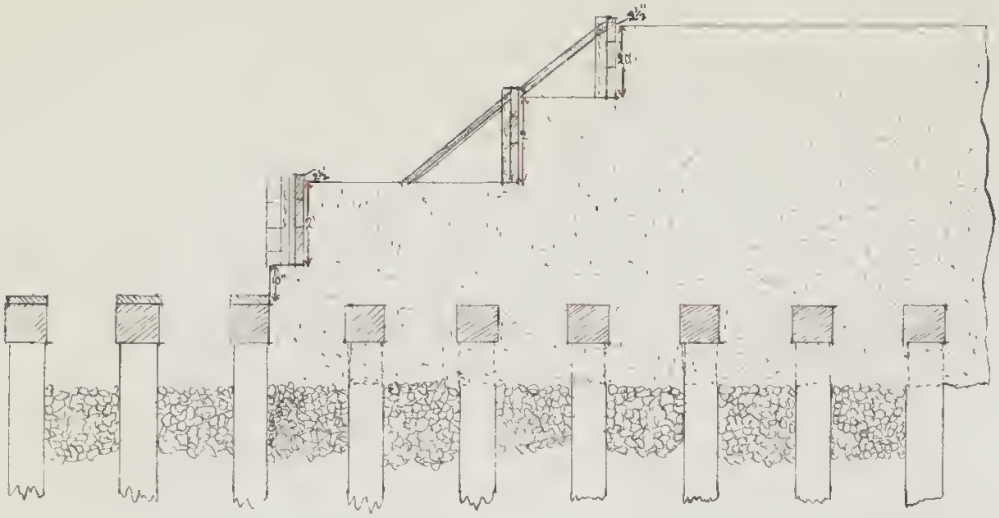


Elevation

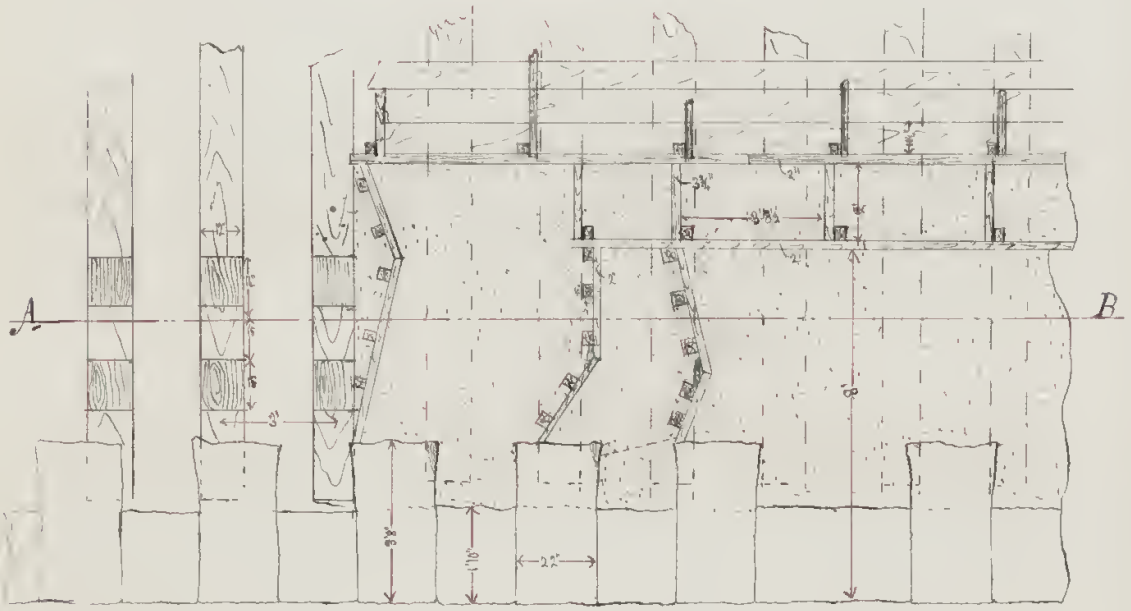
Plan

Detail of Fastening of Binding Frame

Scale 1in.=1ft.



SECTION ON LINE AB.



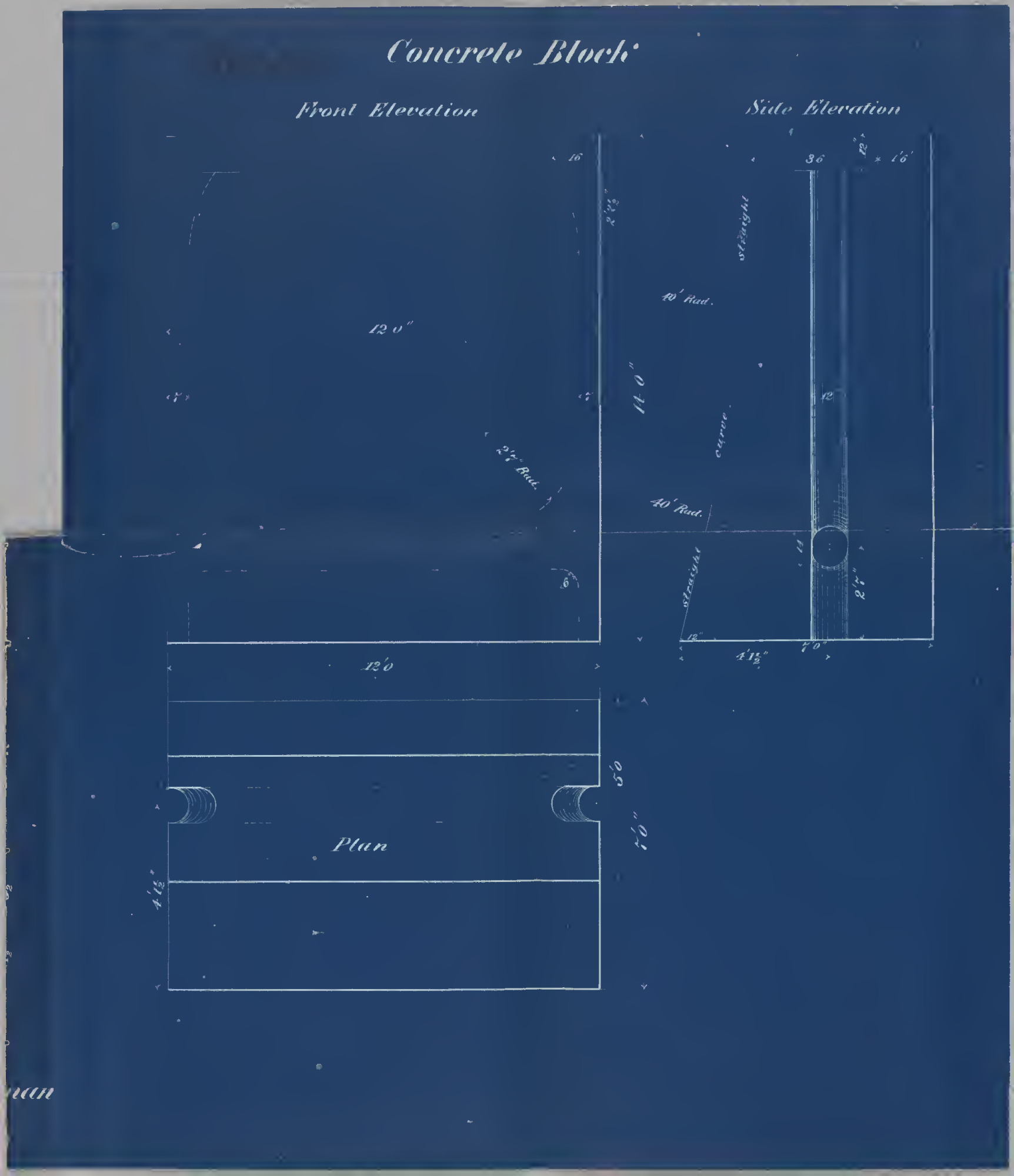
PLAN.

Scale 1"=5'.

CONCRETE BACKING ON BULKHEAD WALL.

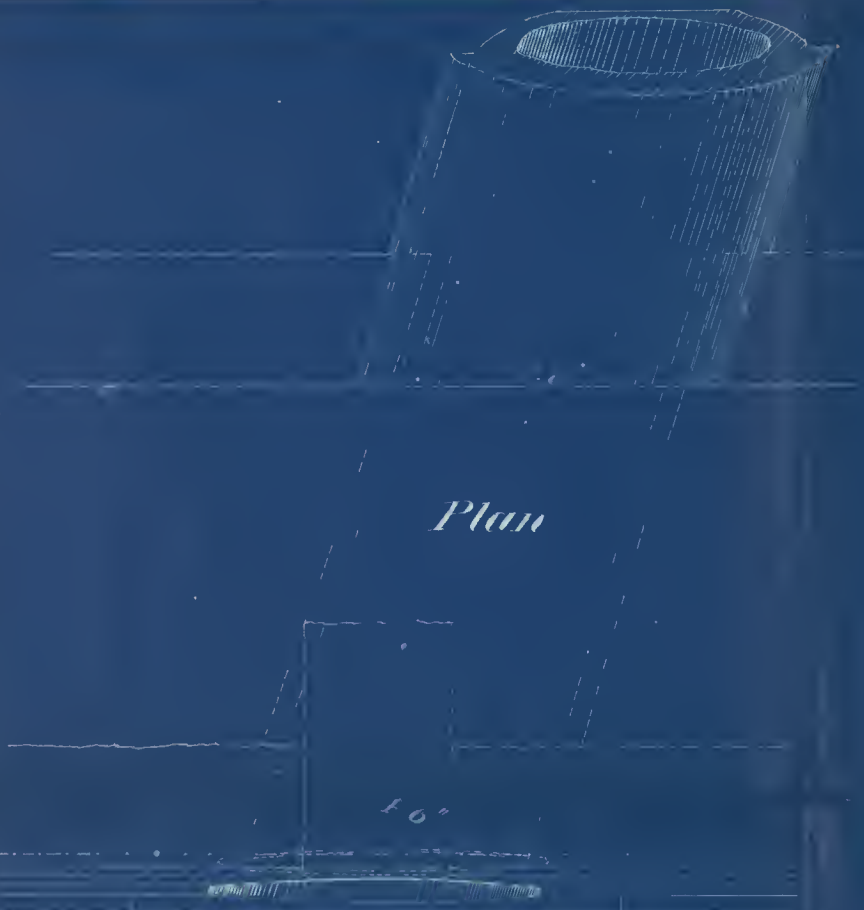
Plate 27.

Concrete Block

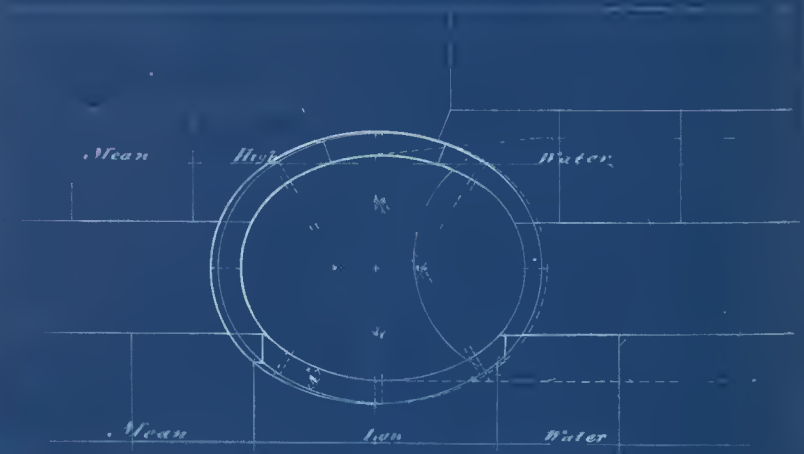


Depart

Plan



Front Elevation



Sewer Outlet

Scale $\frac{1}{2}$" = 1 foot

Section through Center of Sewer

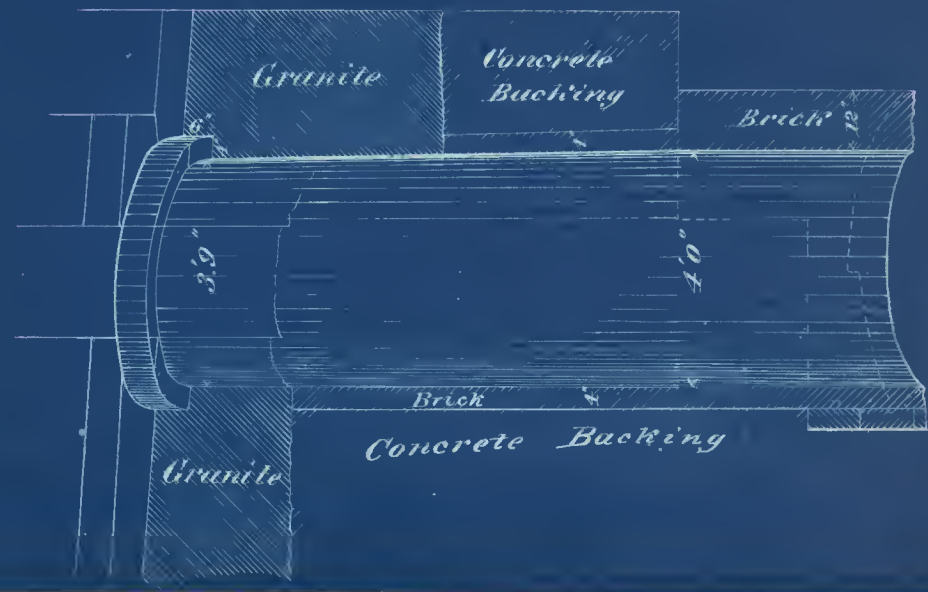


Plate V

Cross Section of Sewer

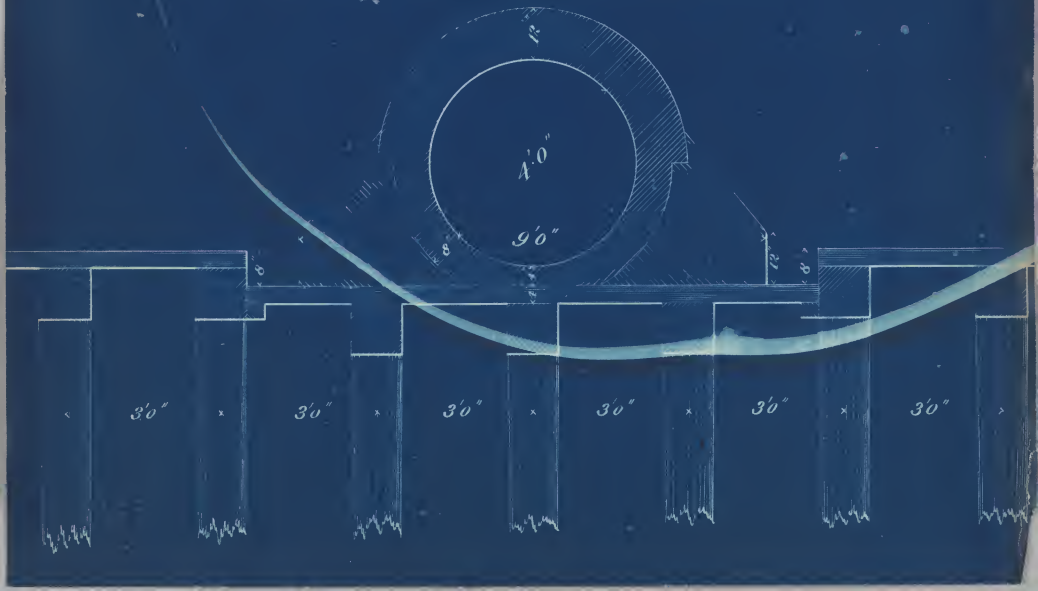


Plate 3

Ahlstrom bolt

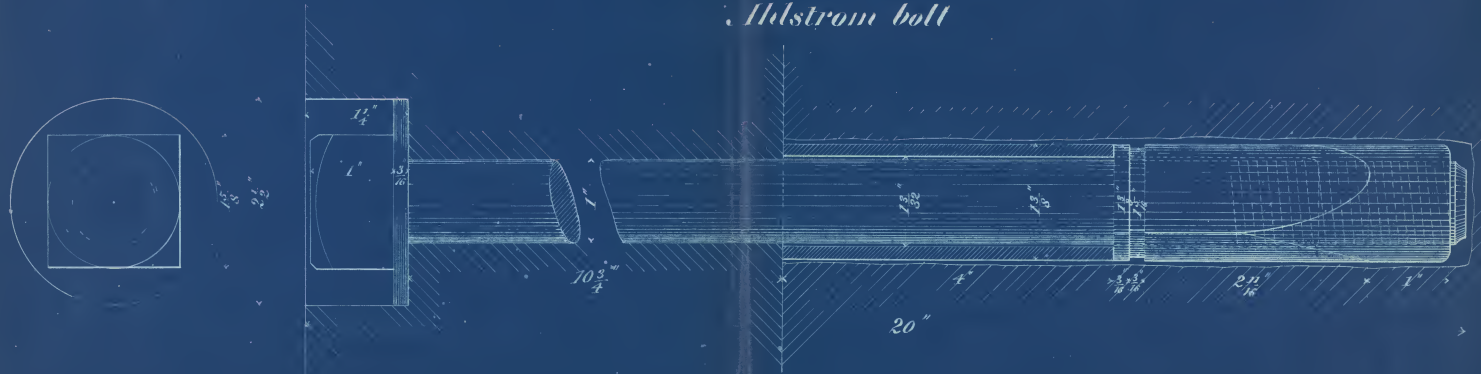
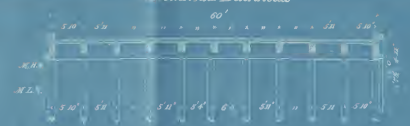


Plate 32.

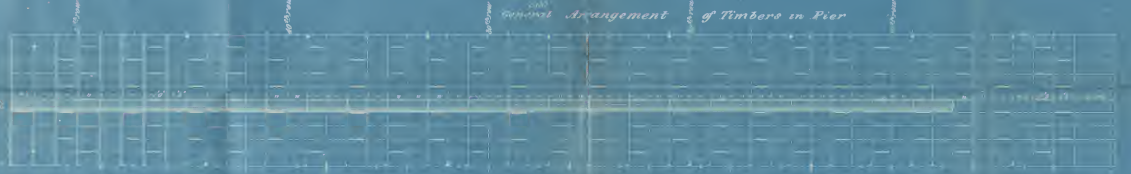
NEW YORK Department of Docks. CITY.

Section near Bulkhead

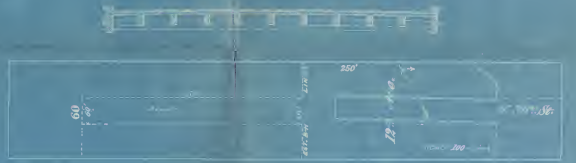


Elevation of outer end.

General Arrangement of Timbers in Pier



Section at Bulkhead



Joints in side caps shown thus ' Scale: 1 inch = 20 feet
" " girders " " †

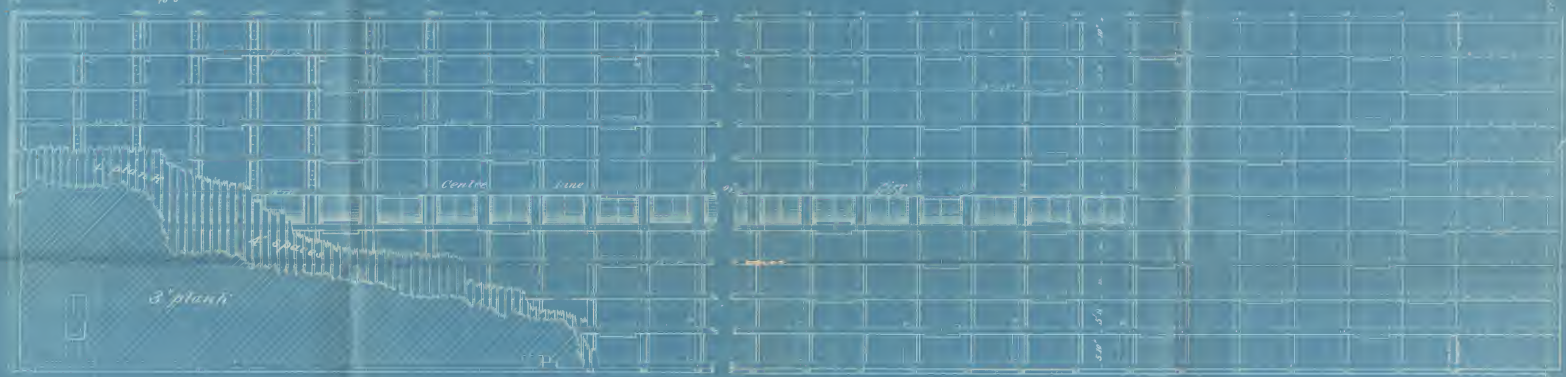
Longitudinal Section

Draughtsman

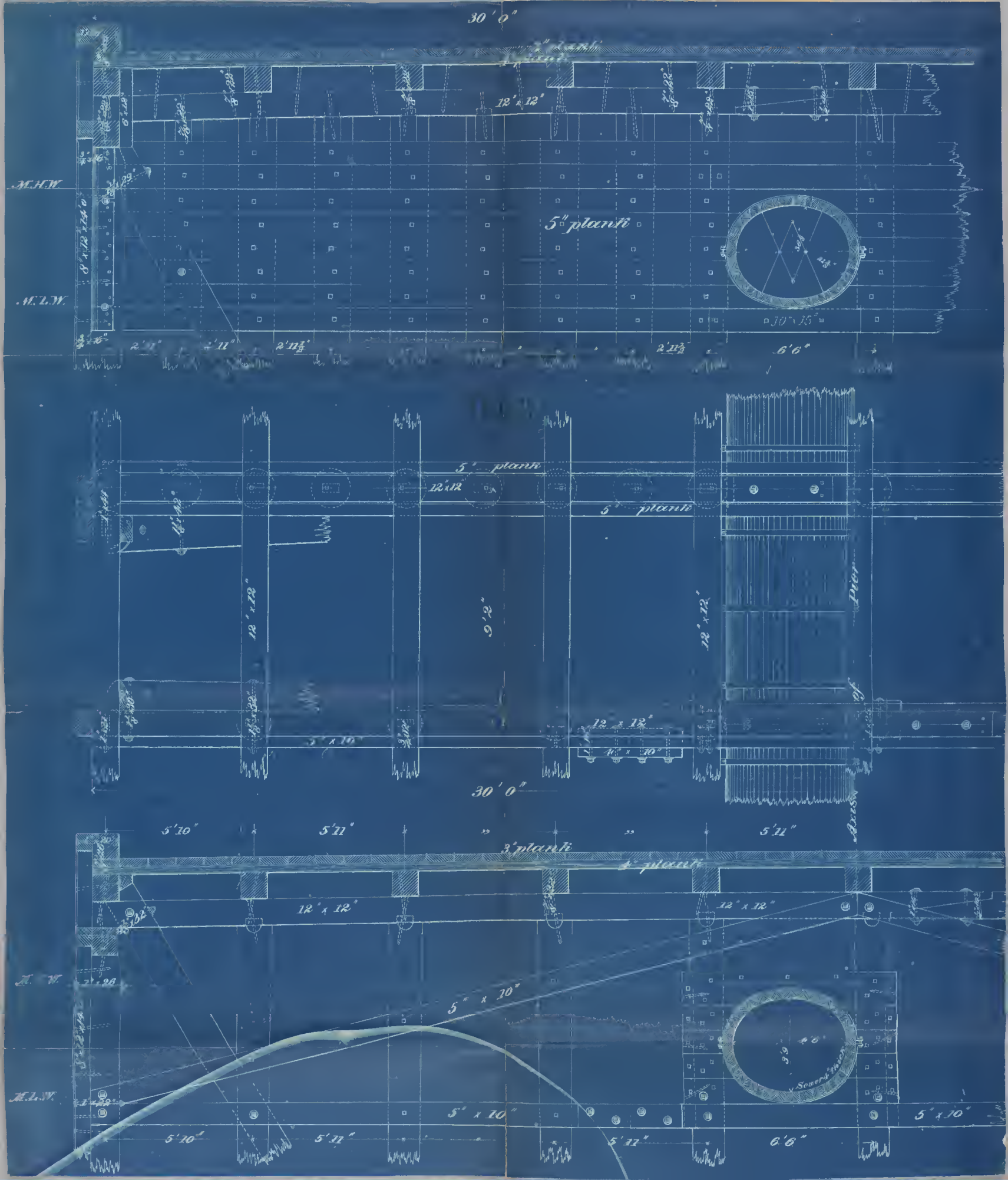
Plate 33

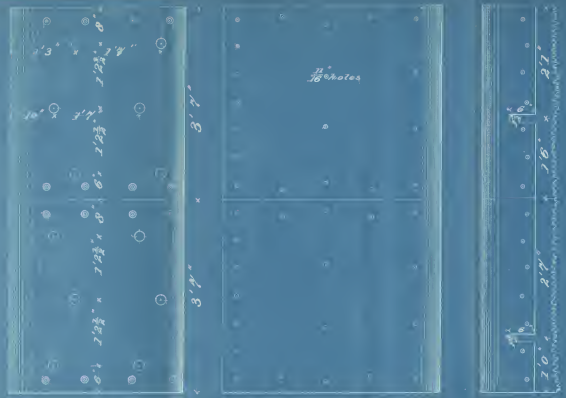
Plan

Scale: 1 inch = 8 feet



Side Elevation


30' 0"
12" x 12"
M.H.W.
M.L.W.
5" plank
30" x 15"
2'11"
2'11"
2'11½"
2'11½"
6'6"
5" plank
12" x 12"
5" plank
12" x 12"
12" x 12"
Pier
12" x 12"
3" x 10"
12" x 12"
12" x 30"
30' 0"
5'10"
5'11"
3" plank
3" plank
12" x 12"
12" x 12"
M. W.
5" x 10"
3'9" x 6'0"
Sewer Inlet
M.L.W.
5" x 10"
5" x 10"
5'10"
5'11"
5'11"
6'6"



4 pairs right hand & 4 pairs left hand Armature plates.

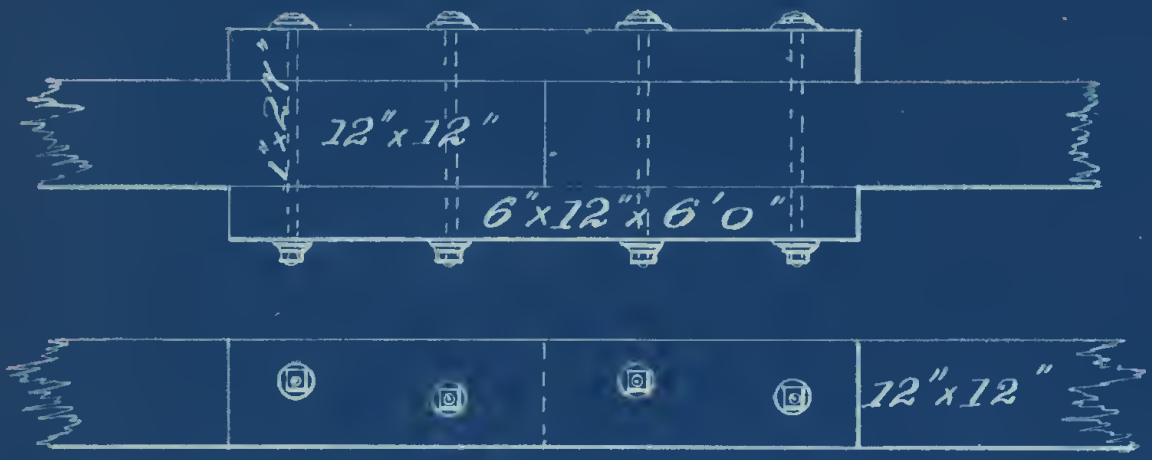
1 pair right hand & 1 pair left hand Corner Armature plates.

Plate 35.

4 Corner bands

TY.

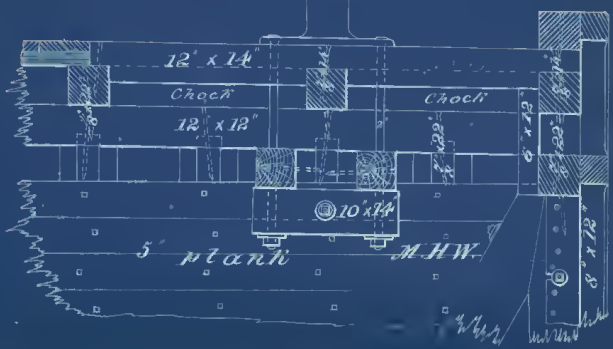
Fish plates



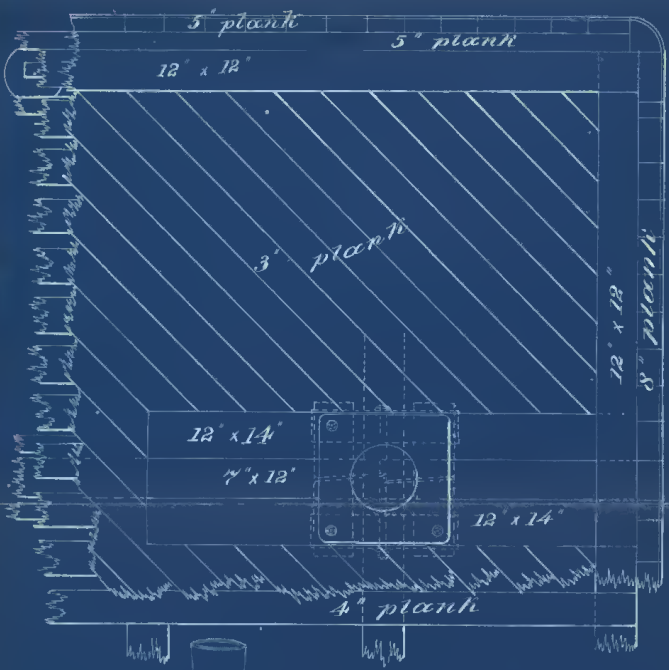
Scarf

Scale: 1/2 inch = 1 foot.

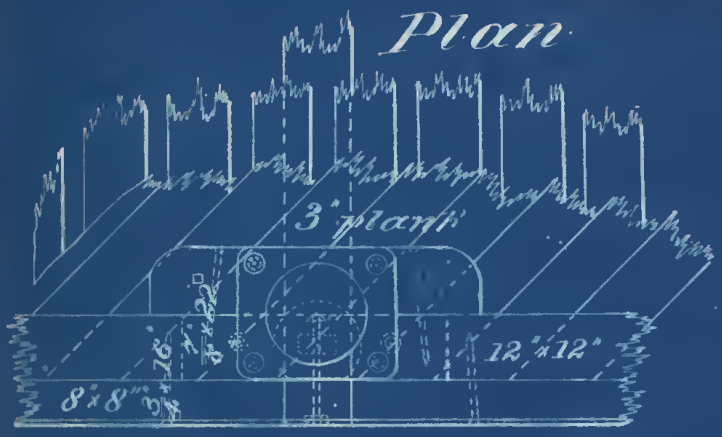
Side Elevation



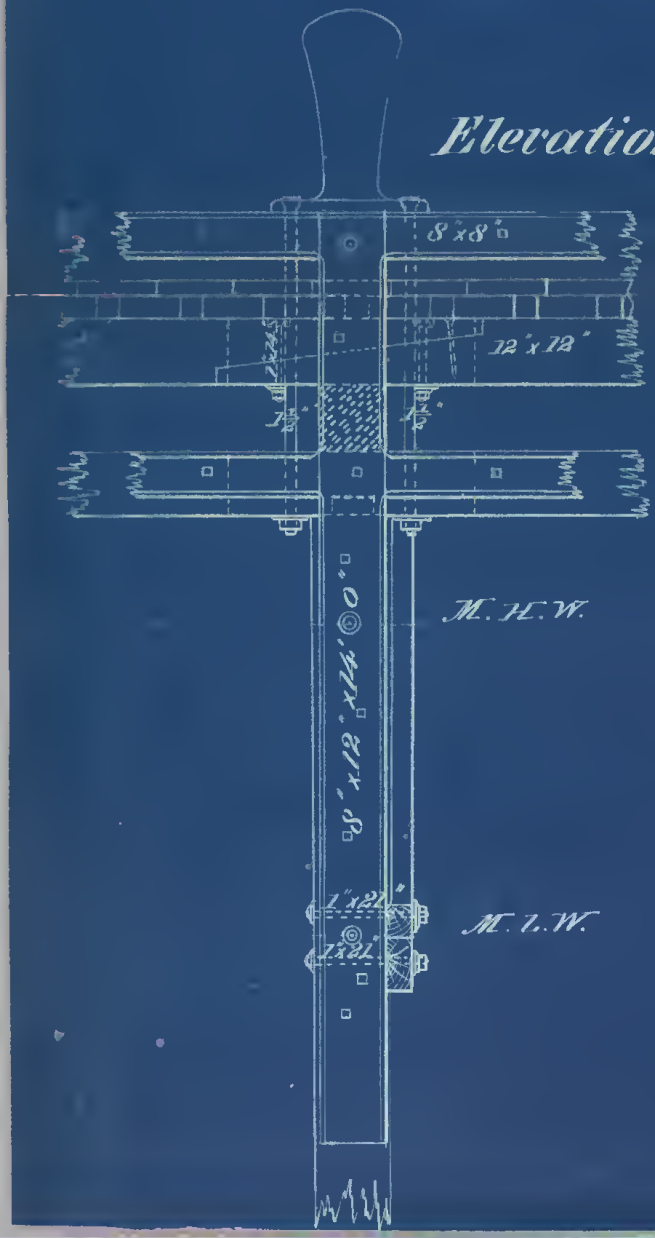
Plan

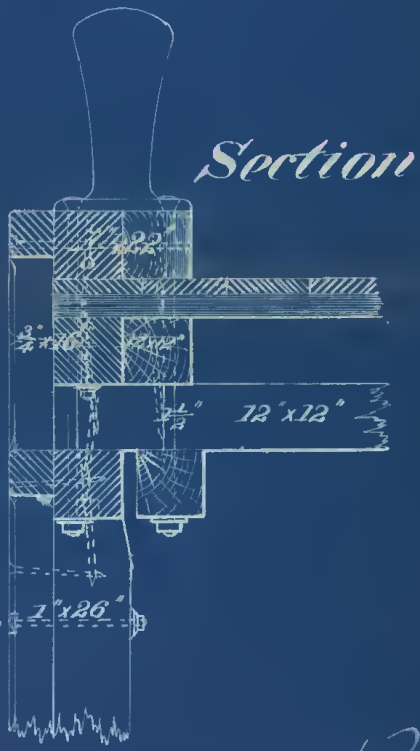


Side elevation Outer end.



Side Mooring Post





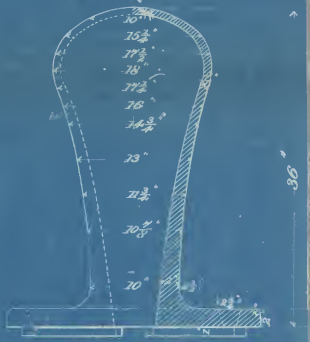
2 Corner Mooring Posts
Elevation & Section

Plate 39.

Plan

3'3"

16 Side Mooring Posts
Elevation & Section.



Plan

29"

Plate 46.

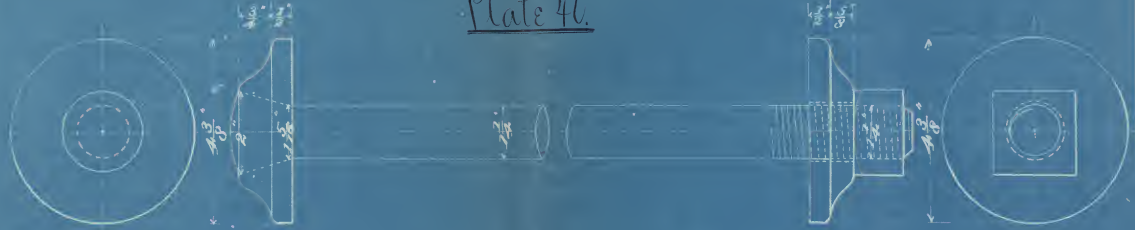
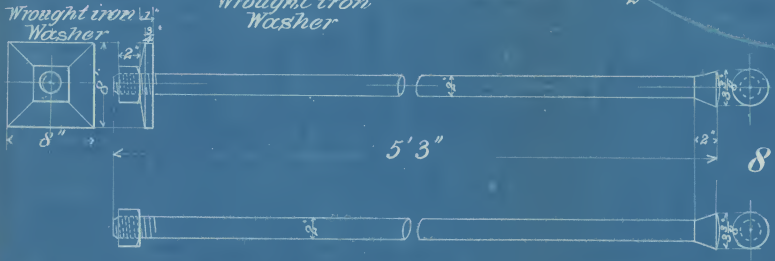


Plate 41.

eks.

4 Strap bolts

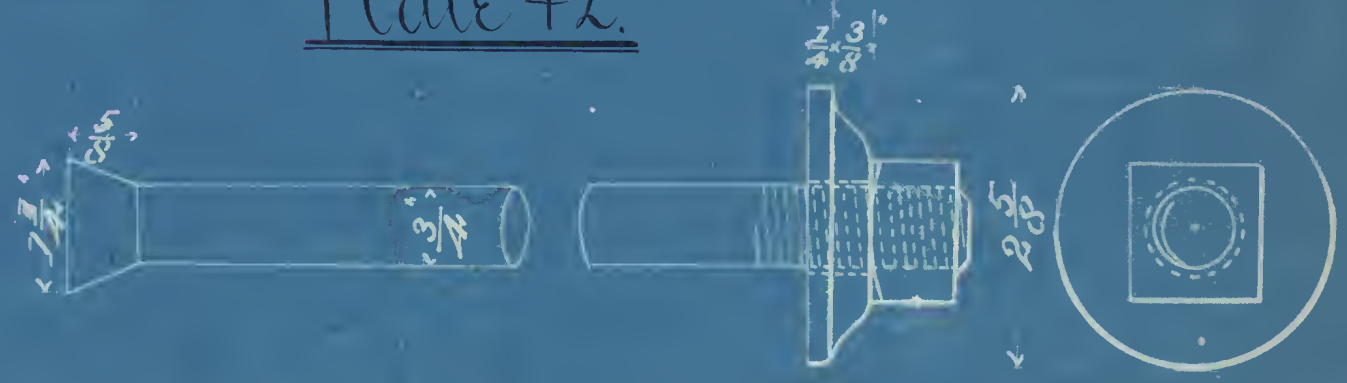
64 Side mooring post bolts.

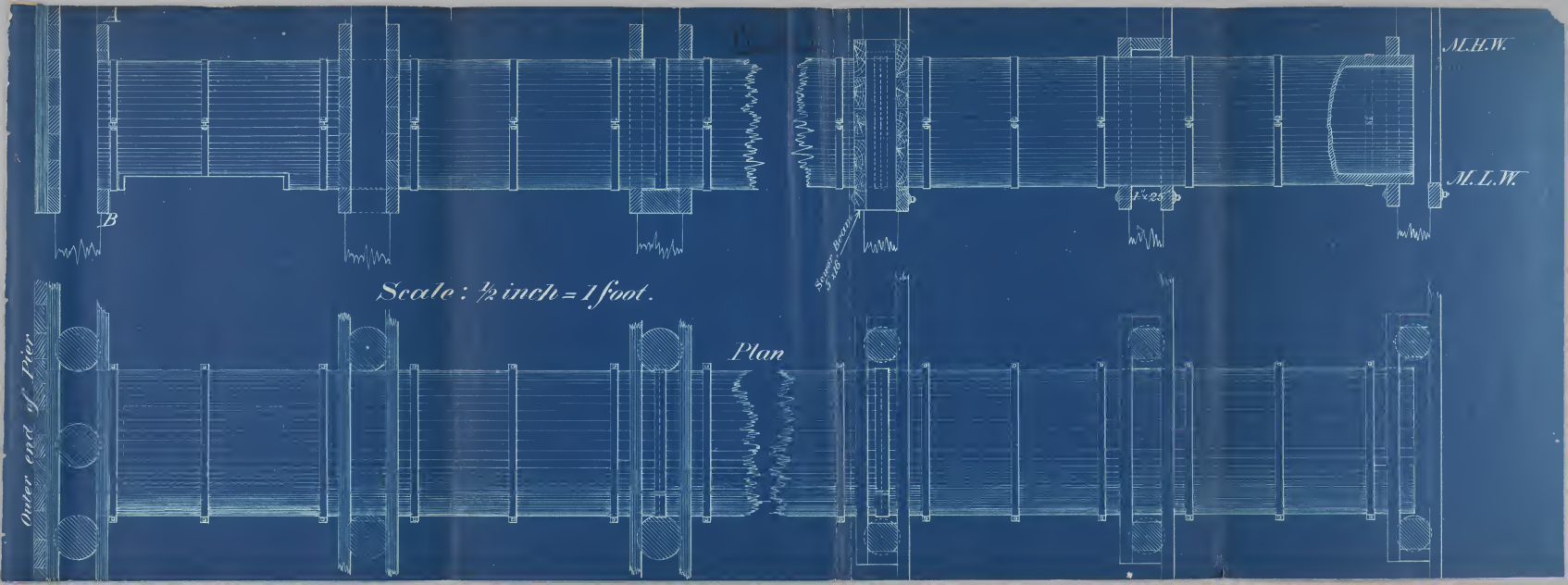


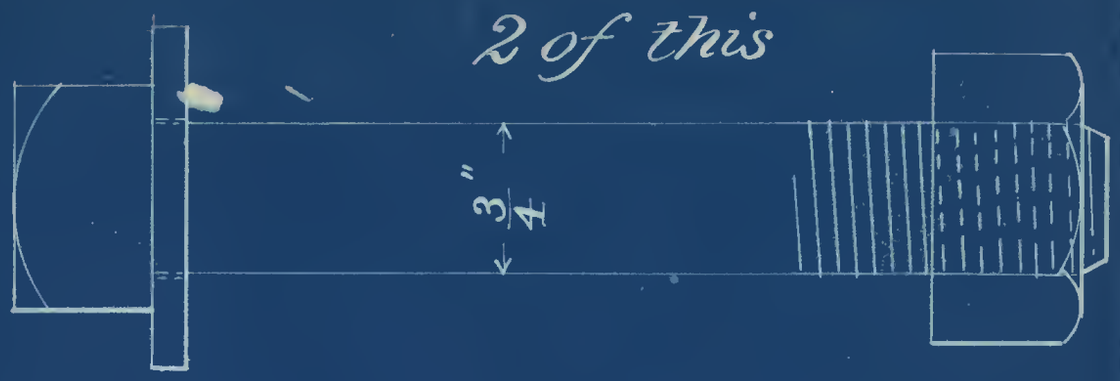
8 Corner mooring post bolts.

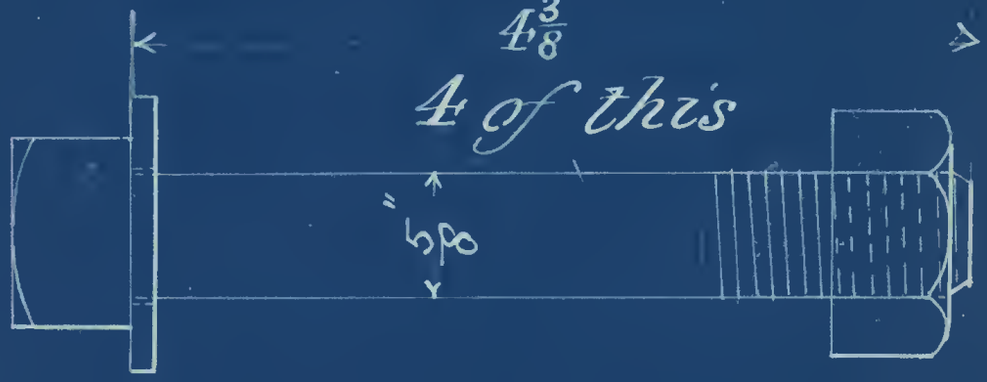
CITY.

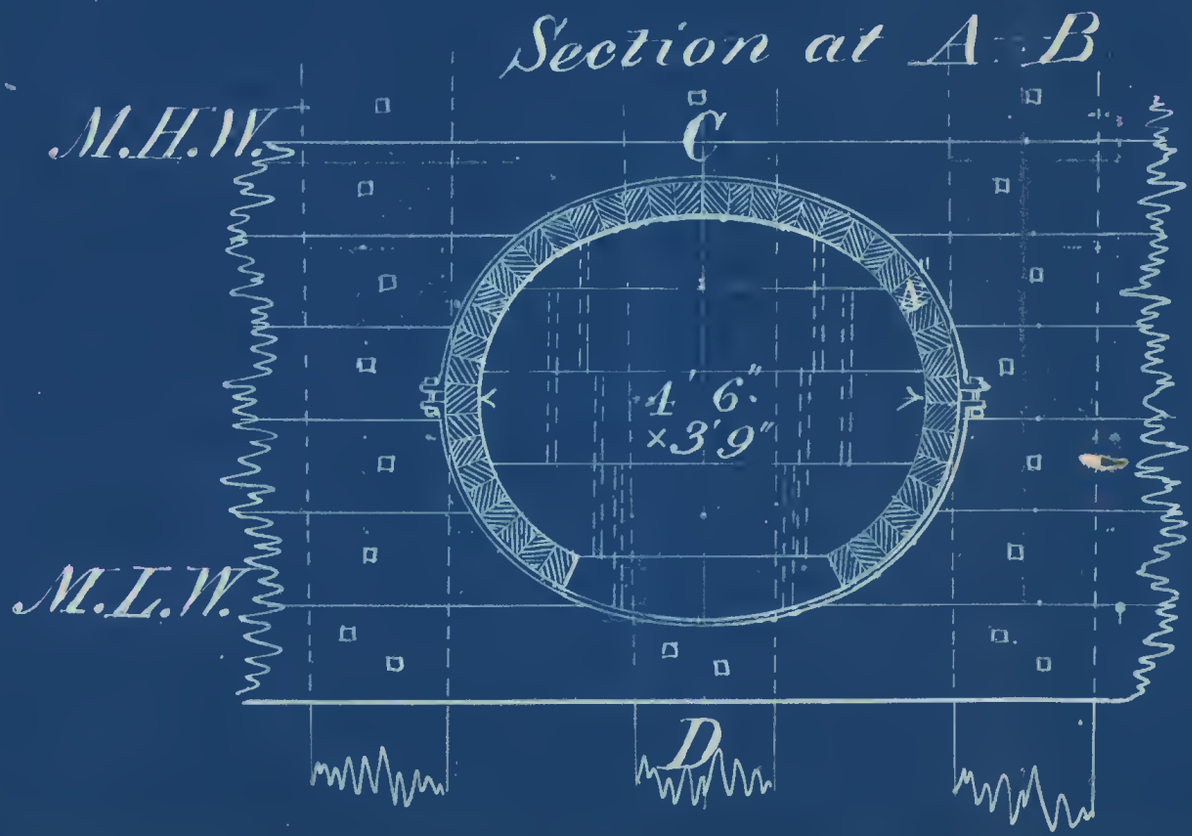
Plate 42.

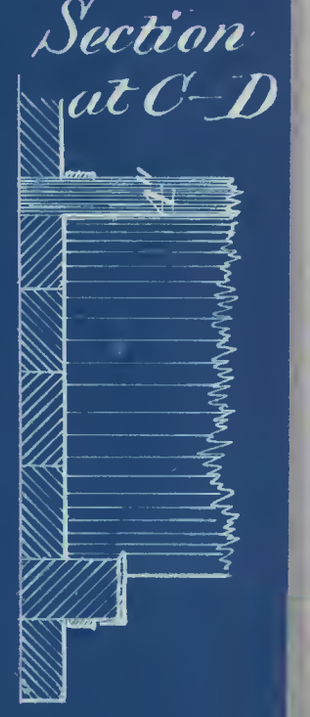



A
B
M.H.W.
M.L.W.
Scale: ½ inch = 1 foot.
Plan
Outer end of Pier.


5"
2 of this
3/4"

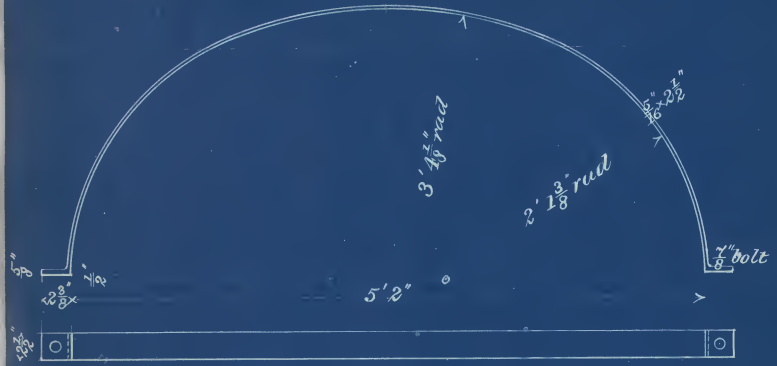

4 3/8
4 of this
5/8"


Section at A-B
M.H.W.
C
4'6"
×3'9"
M.L.W.
D

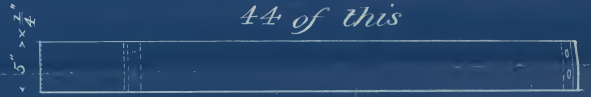

Section
at C-D

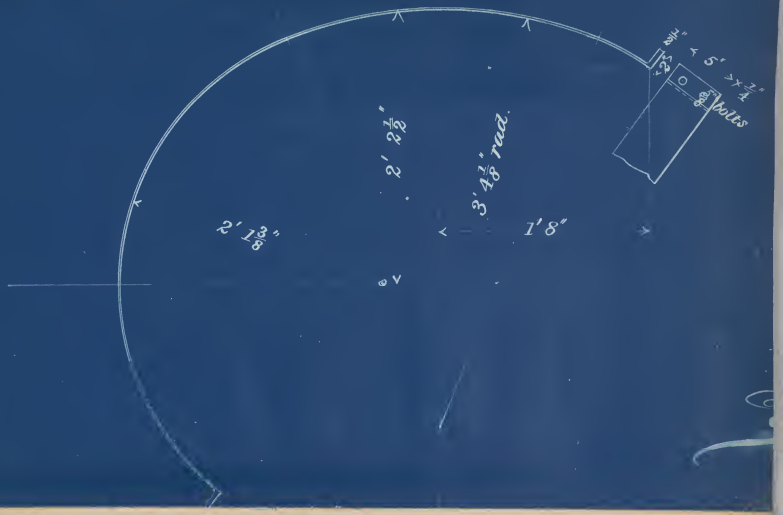
Scale: 1½ inch = 1 foot.

275 of this



44 of this





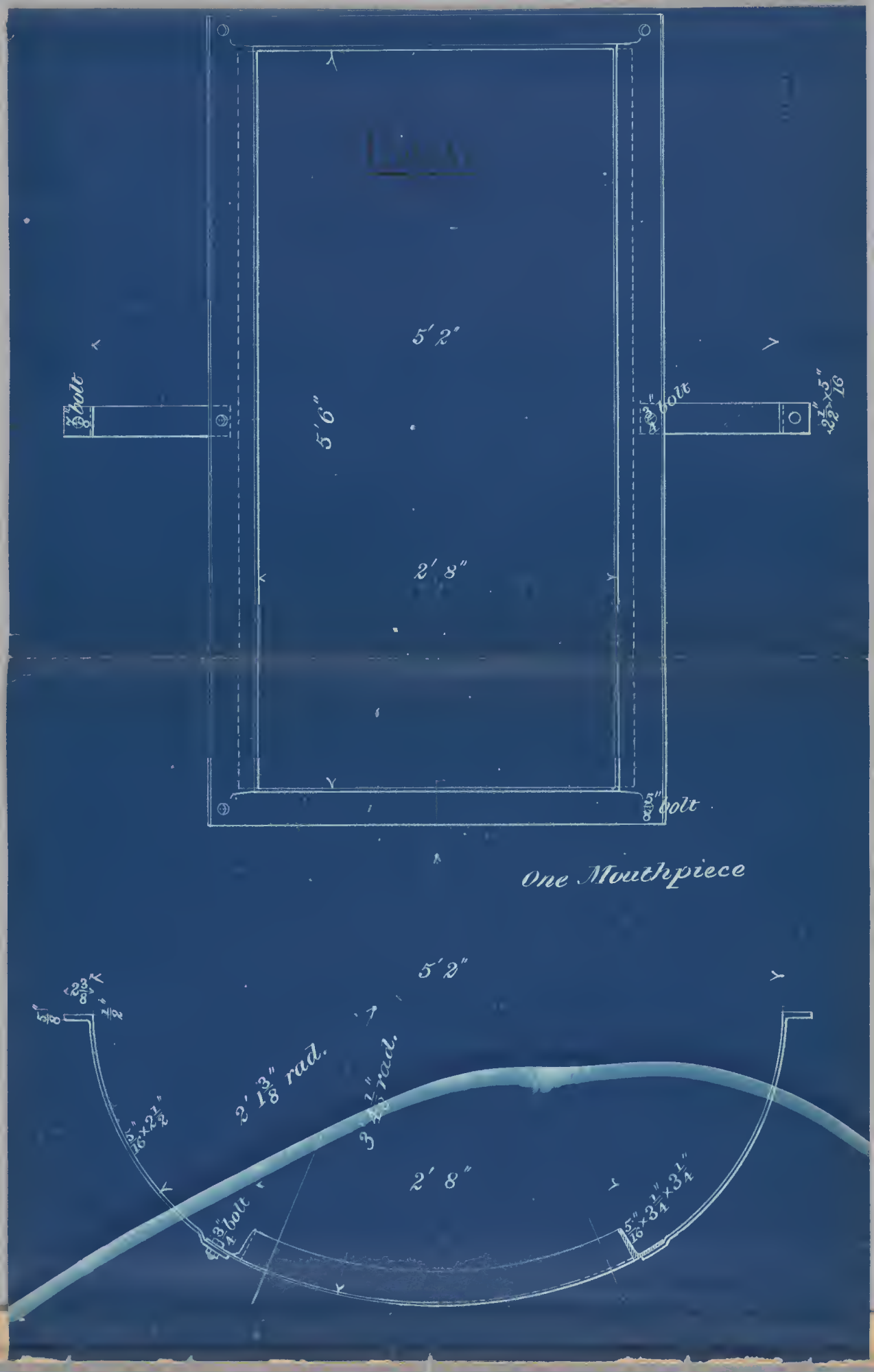
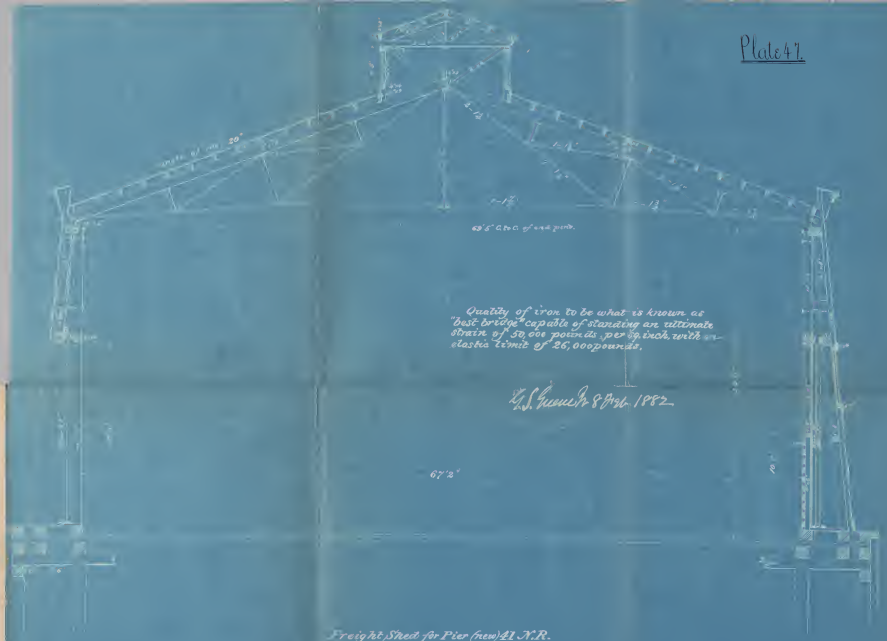

5′ 2″
5′ 6″
2′ 8″
⅝″ bolt
⅝″ bolt
⅝″ bolt
2½″×2½″×5/16
One Mouthpiece
5′ 2″
2′ 1⅜″ rad.
3 1/16″ rad.
2′ 8″
⅝″ bolt

Plate 47.



Section at A.

Freight Shed for Pier (new) 41 N.R.

Scale 1 inch = 4 ft

Section at B